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Western Mining in the Twentieth Century Series

Guy Harris

A CAREER IN MINING CHEMICALS

With an introduction by
Douglas Fuerstenau

Interviews Conducted by
Fredric L. Quivik
in 2001

Since 1954 the Regional Oral History Office has been interviewing leading participants in or well-placed witnesses to major events in the development of northern California, the West, and the nation. Oral history is a method of collecting historical information through tape-recorded interviews between a narrator with firsthand knowledge of historically significant events and a well-informed interviewer, with the goal of preserving substantive additions to the historical record. The tape recording is transcribed, lightly edited for continuity and clarity, and reviewed by the interviewee. The corrected manuscript is indexed, bound with photographs and illustrative materials, and placed in The Bancroft Library at the University of California, Berkeley, and in other research collections for scholarly use. Because it is primary material, oral history is not intended to present the final, verified, or complete narrative of events. It is a spoken account, offered by the interviewee in response to questioning, and as such it is reflective, partisan, deeply involved, and irreplaceable.

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Guy and Elsie Harris

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PREFACE

The oral history series on Western Mining in the Twentieth Century documents the lives of leaders in mining, metallurgy, geology, education in the earth and materials sciences, mining law, and the pertinent government bodies. The field includes metal, non-metal, and industrial minerals. In its tenth year the series numbers thirty-five volumes completed and others in process.

Mining has changed greatly in this century: in the technology and technical education; in the organization of corporations; in the perception of the national strategic importance of minerals; in the labor movement; and in consideration of health and environmental effects of mining.

The idea of an oral history series to document these developments in twentieth century mining had been on the drawing board of the Regional Oral History Office for more than twenty years. The project finally got underway on January 25, 1986, when Mrs. Willa Baum, Mr. and Mrs. Philip Bradley, Professor and Mrs. Douglas Fuerstenau, Mr. and Mrs. Clifford Heimbucher, Mrs. Donald McLaughlin, and Mr. and Mrs. Langan Swent met at the Swent home to plan the project, and Professor Fuerstenau agreed to serve as Principal Investigator.

An advisory committee was selected which included representatives from the materials science and mineral engineering faculty and a professor of history of science at the University of California at Berkeley; a professor emeritus of history from the California Institute of Technology; and executives of mining companies. Langan Swent delighted in referring to himself as "technical advisor" to the series. He abetted the project from the beginning, directly with his wise counsel and store of information, and indirectly by his patience as the oral histories took more and more of his wife's time and attention. He completed the review of his own oral history transcript when he was in the hospital just before his death in 1992. As some of the original advisors have died, others have been added to help in selecting interviewees, suggesting research topics, and securing funds.

The project was presented to the San Francisco section of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) on "Old-timers Night," March 10, 1986, when Philip Read Bradley, Jr., was the speaker. This section and the Southern California section of AIME provided initial funding and organizational sponsorship.

The Northern and Southern California sections of the Woman's Auxiliary to the AIME (WAAIME), the California Mining Association, and the Mining and Metallurgical Society of America (MMSA) were early supporters. Later the National Mining Association became a sponsor. The project was significantly advanced by a generous bequest received in November 1997 upon the death of J. Ward Downey, UC Berkeley alumnus and early member of the mining series advisory committee. His own oral history was completed in 1992. Other individual and corporate donors are listed in the volumes. Sponsors to date include nineteen corporations, four foundations, and 113 individuals. The project is ongoing, and funds continue to be sought.

The first five interviewees were all born in 1904 or earlier. Horace Albright, mining lawyer and president of United States Potash Company, was ninety-six years old when interviewed. Although brief, this interview adds another dimension to a man known primarily as a conservationist.

James Boyd was director of the industry division of the military government of Germany after World War II, director of the U.S. Bureau of Mines, dean of the Colorado School of Mines, vice president of Kennecott Copper Corporation, president of Copper Range, and executive director of the National Commission on Materials Policy. He had reviewed the transcript of his lengthy oral history just before his

death in November, 1987. In 1990, he was inducted into the National Mining Hall of Fame, Leadville, Colorado.

Philip Bradley, Jr., mining engineer, was a member of the California Mining Board for thirty-two years, most of them as chairman. He also founded the parent organization of the California Mining Association, as well as the Western Governors Mining Advisory Council. His uncle, Frederick Worthen Bradley, who figures in the oral history, was in the first group inducted into the National Mining Hall of Fame in 1988.

Frank McQuiston, metallurgist for the Raw Materials Division of the Atomic Energy Commission and vice president of Newmont Mining Corporation, died before his oral history was complete; thirteen hours of taped interviews with him were supplemented by three hours with his friend and associate, Robert Shoemaker.

Gordon Oakeshott, geologist, was president of the National Association of Geology Teachers and chief of the California Division of Mines and Geology.

These oral histories establish the framework for the series; subsequent oral histories amplify the basic themes. After over thirty individual biographical oral histories were completed, a community oral history was undertaken, documenting the development of the McLaughlin gold mine in the Napa, Yolo, and Lake Counties of California (the historic Knoxville mercury mining district), and the resulting changes in the surrounding communities. This comprises forty-three interviews.

Future researchers will turn to these oral histories to learn how decisions were made which led to changes in mining engineering education, corporate structures, and technology, as well as public policy regarding minerals. In addition, the interviews stimulate the deposit, by interviewees and others, of a number of documents, photographs, memoirs, and other materials related to twentieth century mining in the West. This collection is being added to The Bancroft Library's extensive holdings. A list of completed and in process interviews for the mining series appears at the end of this volume.

Interviews were conducted by Malca Chall, Fredric L. Quivik and Eleanor Swent.

Eleanor Swent, Project Director
Western Mining in the Twentieth Century Series

January 2003
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University of California, Berkeley

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Interviews Completed, October 2003

Horace Albright, *Mining Lawyer and Executive, U.S. Potash Company, U.S. Borax, 1933-1962*, 1989

Frank F. Aplan, *Mineral Education Generalist, Professor of Metallurgy and Mineral Processing, 1951-1998*, 2003.

Samuel S. Arentz, Jr., *Mining Engineer, Consultant, and Entrepreneur in Nevada and Utah, 1934-1992*, 1993

James Boyd, *Minerals and Critical Materials Management: Military and Government Administrator and Mining Executive, 1941-1987*, 1988

Philip Read Bradley, Jr., *A Mining Engineer in Alaska, Canada, the Western United States, Latin America, and Southeast Asia*, 1988

Catherine C. Campbell, *Ian and Catherine Campbell, Geologists: Teaching, Government Service, Editing*, 1989

William Clark, *Reporting on California's Gold Mines for the State Division of Mines and Geology, 1951-1979*, 1993

John Robert Clarkson, *Building the Clarkson Company, Making Reagent Feeders and Valves for the Mineral Industry, 1935 to 1998*, 1999

Norman Cleaveland, *Dredge Mining for Gold, Malaysian Tin, Diamonds, 1921-1966; Exposing the 1883 Murder of William Raymond Morley*, 1995

William E. Colby, *Reminiscences* (California mining lawyer), 1954

Harry M. Conger, *Mining Career with ASARCO, Kaiser Steel, Consolidation Coal, Homestake, 1955 to 1995: Junior Engineer to Chairman of the Board*, 2001

James T. Curry, Sr., *Metallurgist for Empire Star Mine and Newmont Exploration, 1932-1955; Plant Manager for Calaveras Cement Company, 1956-1975*, 1990

Donald Dickey, *The Oriental Mine, 1938-1991*, 1996

J. Ward Downey, *Mining and Construction Engineer, Industrial Management Consultant, 1936 to the 1990s*, 1992

Warren Fenzi, *Junior Engineer to President, Director of Phelps Dodge, 1937 to 1984*, 1996

Hedley S. "Pete" Fowler, *Mining Engineer in the Americas, India, and Africa, 1933-1983*, 1992

James Mack Gerstley, *Executive, U.S. Borax & Chemical Corporation; Trustee, Pomona College; Civic Leader, San Francisco Asian Art Museum*, 1991

Robert M. Haldeman, *Managing Copper Mines in Chile: Braden, CODELCO, Minerec, Pudahuel; Developing Controlled Bacterial Leaching of Copper from Sulfide Ores; 1941-1993*, 1995

Guy Harris, *A Career in Mining Chemicals*, 2003

John F. Havard, *Mining Engineer and Executive, 1935-1981*, 1992

Wayne Hazen, *Plutonium Technology Applied to Mineral Processing; Solvent Extraction; Building Hazen Research; 1940-1993*, 1995

George Heikes, *Mining Geologist on Four Continents, 1924-1974*, 1992

Helen R. Henshaw, *Recollections of Life with Paul Henshaw: Latin America, Homestake Mining Company*, 1988

Homestake Mine Workers, Lead, South Dakota, 1929-1993, interviews with Clarence Kravig, Wayne Harford, and Kenneth Kinghorn, 1995

Lewis L. Huelsdonk, *Manager of Gold and Chrome Mines, Spokesman for Gold Mining, 1935-1974*, 1988

William Humphrey, *Mining Operations and Engineering Executive for Anaconda, Newmont, Homestake, 1950 to 1995*, 1996

Hugh C. Ingle, Jr., *Independent Small Mines Operator, 1948 to 1999; Corona Mine*, 2000

James Jensen, *Chemical and Metallurgical Process Engineer: Making Deuterium, Extracting Salines and Base and Heavy Metals, 1938-1990s*, 1993

Arthur I. Johnson, *Mining and Metallurgical Engineer in the Black Hills: Pegmatites and Rare Minerals, 1922 to the 1990s*, 1990

G. Frank Joklik, *Exploration Geologist, Developer of Mt. Newman, President and CEO of Kennecott, 1949-1996; Chairman, Salt Lake 2002 Olympic Winter Games Committee*, 1997

Evan Just, *Geologist: Engineering and Mining Journal, Marshall Plan, Cyprus Mines Corporation, and Stanford University, 1922-1980*, 1989

Robert Kendall, *Mining Borax, Shaft-Freezing in Potash Mines, U.S. Borax, Inc., 1954-1988*, 1994

The Knoxville Mining District, The McLaughlin Gold Mine, Northern California, Volume I, 1998

Anderson, James, "Homestake Vice President-Exploration"

Baker, Will, "Citizen Activist, Yolo County"

Birdsey, Norman, "Metallurgical Technician, McLaughlin Process Plant"

Bledsoe, Brice, "Director, Solano Irrigation District"

The Knoxville Mining District, The McLaughlin Gold Mine, Northern California, Volume II, 1998

Cerar, Anthony, "Mercury Miner, 1935-1995"

Ceteras, John, "Organic Farmer, Yolo County"

Conger, Harry, "President, Chairman, and CEO, Homestake Mining Company, 1977 to 1994"
 Corley, John Jay, "Chairman, Napa County Planning Commission, 1981 to 1985"
 Cornelison, William, "Superintendent of Schools, Lake County" (Includes an interview with John A. Drummond, Lake County Schools Attorney)

The Knoxville Mining District, The McLaughlin Gold Mine, Northern California, Volume III, 1998

Crouch, David, "Homestake Corporate Manager-Environmental Affairs"
 Enderlin, Elmer, "Miner in Fifty-Eight Mines"
 Fuller, Claire, "Fuller's Superette Market, Lower Lake"
 Goldstein, Dennis, "Homestake Corporate Lawyer"
 Guinivere, Rex, "Homestake Vice President-Engineering"

The Knoxville Mining District, The McLaughlin Gold Mine, Northern California, Volume IV, 1998

Gustafson, Donald, "Homestake Exploration Geologist, 1975-1990"
 Hanchett, Bonny Jean, "Owner and Editor, Clearlake *Observer*, 1955-1986"
 Hickey, James, "Director of Conservation, Development, and Planning for Napa County, 1970 to 1990"
 Jago, Irene, "The Jagos of Jago Bay, Clear Lake"
 Jonas, James, "Lake County Fuel Distributor"
 Koontz, Dolora, "Environmental Engineer, McLaughlin Mine, 1988-1995"

The Knoxville Mining District, The McLaughlin Gold Mine, Northern California, Volume V, 1998

Kritikos, William, "Operator, Oat Hill Mine"
 Landman, John, "Rancher, Morgan Valley"
 Lyons, Roberta, "Journalist and Environmentalist"
 Madsen, Roger, "Homestake Mechanical Engineer"
 Magoon, Beverly, "Merchant and Craft Instructor, Lower Lake"
 McGinnis, Edward, "Worker at the Reed Mine"

The Knoxville Mining District, The McLaughlin Gold Mine, Northern California, Volume VI, 1999

Robert McKenzie, "McKenzies in Monticello, Berryessa Valley"
 Harold Moskowitz, "Napa County Supervisor"
 Marion Onstad, "Neighbor and Employee of the McLaughlin Mine, 1980-1995"
 Ronald Parker, "Resident Manager of the McLaughlin Mine, 1988-1994"
 Richard Stoehr, "Homestake Engineer and Geologist to Senior Vice-President and Director"
 Joseph Strapko, "Exploration Geologist, McLaughlin Mine Discovery, 1978"

The Knoxville Mining District, The McLaughlin Gold Mine, Northern California, Volume VII, 2000

Jack Thompson, "General Manager, McLaughlin Mine, 1981-1988"
 Twyla Thompson, "County Supervisor, Yolo County, 1975-1985"
 Avery Tindell, "Capay Valley Environmentalist"
 John Turney, "McLaughlin Metallurgist: Pioneering Autoclaving for Gold"
 Della Underwood, "Knoxville Rancher, McLaughlin Mine Surveyor"
 Walter Wilcox, "County Supervisor, Lake County, 1979-1995"
 Peter Scribner, "Boyhood at the Knoxville Mine, 1941-1944"

The Knoxville Mining District, The McLaughlin Gold Mine, Northern California, Volume VIII, 2002

Dean Enderlin, "Mine Geologist, Reclamation Manager, McLaughlin Mine"

Susan Harrison, "McLaughlin Natural Reserve"

Raymond Krauss, "Environmental Manager, McLaughlin Mine"

Marian Lane, *Mine Doctor's Wife in Mexico During the 1920s*, 1996

John Sealy Livermore, *Prospector, Geologist, Public Resource Advocate: Carlin Mine Discovery, 1961; Nevada Gold Rush, 1970s*, 2000

J. David Lowell, *Using Applied Geology to Discover Large Copper and Gold Mines in Arizona, Chile, and Peru*, 1999

Plato Malozemoff, *A Life in Mining: Siberia to Chairman of Newmont Mining Corporation, 1909-1985*, 1990

Donald H. McLaughlin, *Careers in Mining Geology and Management, University Governance and Teaching*, 1975

James and Malcolm McPherson, *Brothers in Mining*, 1992

Frank Woods McQuiston, Jr., *Metallurgist for Newmont Mining Corporation and U.S. Atomic Energy Commission, 1934-1982*, 1989

Gordon B. Oakeshott, *The California Division of Mines and Geology, 1948-1974*, 1988

James H. Orr, *An Entrepreneur in Mining in North and South America, 1930s to 1990s*, 1995

Vincent D. Perry, *A Half Century as Mining and Exploration Geologist with the Anaconda Company*, 1991

Patrick Purtell, *Maintenance and Management at the McLaughlin Mine, 1985 to 1997*, 1999

Carl Randolph, *Research Manager to President, U.S. Borax & Chemical Corporation, 1957-1986*, 1992

John Reed, *Pioneer in Applied Rock Mechanics, Braden Mine, Chile, 1944-1950; St. Joseph Lead Company, 1955-1960; Colorado School of Mines, 1960-1972*, 1993

Joseph Rosenblatt, *EIMCO, Pioneer in Underground Mining Machinery and Process Equipment, 1926-1963*, 1992

Robert Shoemaker, *Metallurgical Engineer: Union Carbide, Bechtel, San Francisco Mining Associates; Metallurgical Consultant, 1953 to 2000*, 2001

Eugene David Smith, *Working on the Twenty-Mule Team: Laborer to Vice President, U.S. Borax & Chemical Corporation, 1941-1989*, 1993

Simon Strauss, *Market Analyst for Non-ferrous Metals and Non-metallic Minerals, Journalist, Mining Corporation Executive, 1927-1994*, 1995

Langan W. Swent, *Working for Safety and Health in Underground Mines: San Luis and Homestake Mining Companies, 1946-1988*, 1995

James V. Thompson, *Mining and Metallurgical Engineer: the Philippine Islands; Dorr, Humphreys, Kaiser Engineers Companies; 1940-1990s*, 1992

William Wilder, *Owner of One Shot Mining Company: Manhattan Mercury Mine, 1965-1981*, 1996

Alexander M. Wilson, *Leading a Changing Utah Construction and Mining Company: Utah International, GE-Utah, BHP-Utah, 1954 to 1987*, 2000

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THE GUY HARRIS ORAL HISTORY OF
THE WESTERN MINING IN THE TWENTIETH CENTURY ORAL HISTORY SERIES

The Regional Oral History Office, on behalf of future researchers, would like to express its thanks to the following corporations, organizations, and individuals whose encouragement and support have made possible this oral history project of Guy Harris.

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INTRODUCTION by Douglas W. Fuerstenau

Guy Harris was a person whose work had real impact on this world and we all are better off that Guy passed through it. From our many conversations, I know that he had real dedication to his family, to his religion, to his colleagues, and to his profession.

I had known of the technical contributions that Guy had made to mining chemicals and to processing in the mineral industry long before I met him. Guy was an extraordinarily gifted and creative organic chemist with a long list of very significant chemical achievements in the Mining Chemicals Division of Dow Chemical Company. The person at Dow whom I had gotten to know quite well through the years was Elmer Tveter, who regularly attended annual meetings of the AIME. Elmer was a close associate of Guy and an outstanding flotations testing engineer, both in the laboratory and in flotation plants. Even though Guy worked only fifteen miles away from Berkeley at the Dow Research Laboratories in Walnut Creek, almost all of my early interaction with him was at international meetings. I first met Guy personally in 1963 at the International Mineral Processing Congress in France where I had traveled with Elmer Tveter, then in 1970 in Yugoslavia, in Brazil in 1977, and in Rome in 1980 at a mineral reagents symposium. At all of these congresses, my interaction with Guy was quite extensive, such as spending a week on a technical tour traveling through Yugoslavia by bus. It was only about 1980 that I first visited Guy in his laboratory at Dow during a consulting matter over the development of a new frother for molybdenite flotation.

Some information about the magnitude of chemical reagent consumption by the mining industry should help in understanding the significance of Guy's work. From 1960 to 1895, the US Bureau of Mines collected data every five years on operating flotation plants in the United States, including details on reagent consumption. In 1980, about the time that Guy retired, in the United States there were 239 flotation plants, which treated 440,400,000 tonnes of ore with a consumption of 772,100 tonnes of chemical reagents, or 1.75 kg per tonne of ore processed. Of the two major types of ore treated, one was a sulfide (copper) and the other nonmetallic (phosphate). In 1980, the amount of copper ore processed totaled 205,400,000 tonnes, producing 4,200,000 tonnes of concentrates while consuming 382,900 tonnes of chemical reagents. In the case of phosphate minerals, 108,700,000 tonnes of ore were treated by flotation to produce 26,600,000 tonnes of concentrates at a reagent consumption of 221,200 tonnes. Clearly, the magnitude of mining chemical usage is huge. Because of the unfortunate demise of the Bureau of Mines, such data are no longer available, and for the record, part of the 1985 Bureau of Mines Flotation Summary is included in the appendix.

Although Guy's professional career was in industrial chemistry, he had a strong passion for education. Some forty years ago, he took a leave of absence from Dow to spend two years teaching chemistry at the University of Ghana. He was very proud that he had inspired two of his students there to go on to obtain PhD degrees, one at Berkeley and one at the Royal School of Mines in London. For a few years, Guy taught chemistry as an adjunct professor after the founding of John F. Kennedy University. He spent a few months at Penn State University and for the last several years, he was associated with me at Berkeley in the University of California.

Nearly fifteen years ago at Berkeley, we had the opportunity of preparing a proposal for a major DOE project to investigate the removal of sulfur from coal. It occurred to me to invite Guy to be part of this project to design new flotation reagents that might act as selective depressants for pyrite in coal flotation. We were awarded the contract and Guy had a significant role in its success. I only wished that I had thought of bringing Guy into our group years earlier.

From that time on, Guy came to the Berkeley campus quire regularly, once or twice each week, and several graduate students had close interaction with him starting back then and right up to a few weeks before he died. I recall with pleasure Guy's generally cheerful arrival at my office, and his often starting right in with the presentation of an enthusiastic new idea that he had come up with. I know that those students who worked with Guy consider themselves very fortunate to have been associated with him on their research for their master's and doctor's theses.

Guy had a keen eye for patentable ideas. He always looked at reagent possibilities in terms of costs of materials for making them--if too expensive, they would never be used. Working with graduate students, Guy developed certain reagents that can act as flotation collectors for coal, either fresh or oxidized coal. He was extremely disappointed that the University of California patent people let our application go to the last day, when it was too late. Later, we did obtain patents on some new depressants for pyrite in sulfide flotation.

About five years ago, Guy and I were invited to China, together with his daughter Alice and my wife Peggy. Guy gave several lectures in Beijing and in Huainan, and I would like to say that I learned something new from Guy's lectures. In 2000, Guy was named an Honorary Professor at the Huainan Institute of Technology. Some few years ago, he was named a Distinguished Member of SME/AIME (the Society for Mining, Metallurgy and Exploration), recognition given to only one percent of the membership of the society, which has a total membership of 12,000 engineers and scientists. SME recognized the major impact that Guy's reagent inventions had on the production of copper worldwide. Last year, shortly before his death, Guy was nominated for the Frank Aplan Award. That nomination is given in the appendix to show the high regard that others in the field had for him.

Even the last time that Guy was in my office, he wrote on the blackboard several ideas for new reagents that might be useful for improving flotation separations. His mind was extremely fertile, even to his last days. This year, 2002, we had a technical paper published jointly with a former graduate student, Dr. Renhe Jia. This was in Guy's 88th year and there are not many people in this world who have made professional contributions at that stage in their life. The mining chemicals that he invented will be a lasting legacy of his creative work.

Douglas Fuerstenau
Professor Emeritus
Department of Materials Science and Engineering

University of California, Berkeley
Berkeley, California
November, 2002

INTERVIEW HISTORY -- Guy Harris

Guy Harris retired as a chemist with Dow Chemical in 1982. At Dow, he had been responsible for the development of Z200, a chemical reagent used by mining companies in the flotation process to separate copper minerals from waste minerals, called gangue. Guy's invention of Z200 is credited with increasing the recovery of copper worldwide by 80 million pounds annually. Even in retirement Guy maintained a keen intellectual interest in chemical processes, especially those related to the mining industry. After retiring from Dow, he worked on research projects with Doug Fuerstenau, Professor of Metallurgy at the University of California at Berkeley. Professor Fuerstenau is also a member of the advisory committee for ROHO's Mining History Project. Knowing of Guy's long history with Dow and of the importance of Z200 to the mining industry, as well as for his work in the development of ion exchange processing of uranium ores and in mentoring many others who furthered his research, Professor Fuerstenau recommended that ROHO interview Guy. Because Eleanor (Lee) Swent was busy with some other interviews, and because of my familiarity with flotation and other processes in extractive metallurgy, Lee asked me to conduct the interview, and I gladly accepted the assignment.

Professor Fuerstenau introduced me to Guy over lunch at the U.C. Faculty Club. I immediately learned that Guy loved to tell stories, to use anecdotes as a means of explaining. After that first meeting, I next drove out to Guy's home in Concord, where I met his wife Elsie and daughter Sara. Guy showed me his files and some photos, and he talked generally about the course of his life and career. He was especially pleased to show me documents and photographs of Franciscan University, the school in Steubenville, Ohio, of which he had become a benefactor in recent years. From the lunch and my visit to his home, I was able to devise an outline for his interview, which I sent to him so that he could work further on the recollections of his life in preparation for the oral history.

Guy and I conducted his interviews in the Press Room of the Bancroft Library. He continued to enjoy making visits to the U.C. campus, so interviewing him there was convenient. He sometimes coordinated our interview sessions with appointments with Doug Fuerstenau. We completed Guy's oral history in four sessions: 21 March, June 7, 13 July, and 4 October 2001. During that time, he was receiving treatment for cancer, which caused the postponement of the second session until June. Even then, the doctors were trying to adjust his medication levels. Guy thought he was ready to resume the interview in June, but during that session he tired rather quickly and became a bit disoriented toward the end, so we adjourned early. By July, though, he was back to his gregarious self, happy to share more anecdotes to illustrate his work at Dow. Guy was at his best during the fourth and final interview when, among other things, he described his experience of coming to faith in Jesus Christ. During earlier interview sessions, he did not hide the fact that for most of his life he was an agnostic and rather a curmudgeon when it came to others' Christian faith, which makes his story especially engaging. Anyone listening to or reading Guy's interview will notice that in discussing other topics he typically gave rather short answers, and I often had to encourage him to elaborate with follow-up questions. When describing his conversion experience and his baptism, however, he talked at length and with great joy, not needing any encouragement from me.

The interviews were transcribed in our office, and lightly edited by myself and Eleanor Swent. Guy Harris died on 16 November 2002, before he had been able to review all the transcripts of his interview.

Fredric Quivik, Interviewer
October, 2003

INTERVIEW WITH GUY HARRIS

[Interview 1: March 21, 2001] [Begin Tape 1, Side A]

Quivik: Good morning. My name is Fred Quivik, and I'm interviewing Guy Harris, a longtime chemist with Dow Chemical Company. It's March 21st, 2001 and we are in the Press Seminar room at Bancroft Library, on the campus of the University of California at Berkeley. Good morning, Mr. Harris. We're here to interview you about your life and career as a chemist. I wonder if you could start by describing some things about your family background before we get to your career as a chemist. Could you start by saying something about your father's family?

Harris: My grandfather's mother was Pennsylvania Dutch, which is German. His father was north Irish, and his name was John. John, at the age of fourteen, ran away from home and lied about his age and enlisted in the Union Army--Civil War. His parents tracked him down and he ran away again, only this time he used a false name and they weren't able to track him down at all.

He was a railroad man. He worked originally for the Atlantic and Pacific Railroad, which became part of the Santa Fe. His wife was Sarah Moore, and became Sarah Harris. He worked for the Santa Fe, and he had a rather lowly position. One day he was working on wheels of some freight cars and he put up the blue flag. Someone came along and didn't see him and said, "What's this blue flag for? Someone forgot it." And they took it. The switch engine came up and no blue flag, so they connected with the freight cars and he got badly mangled under the car. He lived about a year and a half after that. And that was the end of his life.

Quivik: Approximately what year was that?

Harris: My niece will have that.

Quivik: And where was he living when he died?

Harris: Hollywood.

Quivik: California?

Harris: Yes. They lived out along the railroad in Needles and northern Arizona. My dad was born in El Paso, Texas. My granddad was buried in the Hollywood cemetery, and I saw his grave marker when my aunt, my dad's sister, died in 1922 and we went to the funeral mass. There was all this smoke and stuff. It was real scary for a little kid that was only eight years old. We went to the cemetery. They were poor. There was a pillar about four feet high, "Woodmen of the World." I remembered that.

Quivik: Was the smoke from incense?

Harris: Yes, at the mass. At the cemetery my Aunt Etta had him buried next to her dad. They had originally bought it for my granddad and my grandmother. Aunt Etta's husband was a butcher, and there was no union, so it really wasn't a very lucrative position.

Quivik: Where were you living at the time?

Harris: San Bernardino. We'd take the big red cars into Los Angeles and transfer and get out at the street they lived on in Hollywood. My grandmother had married again, to Uncle Jake. Uncle Jake, his claim to fame was he took the Nellie Bly Special around the world in eighty days, and he was selected to run the train over that particular division.

My dad, for those days, was reasonably well educated because he'd gone through the tenth grade. Young men were expected to get enough education to read and write, and then get a job. He was a railroad fireman, but they had a picture of him and couple of other men coming out of a saloon. Rule G was that if you're caught drinking, you're sacked, you're fired, you're canned. So when he married my mother, the man who was head of the Santa Fe at the time west of Albuquerque, Mr. Wall, gave my dad a job back.

My dad was very unhandy, but he knew how to make a steam boiler talk. So he ran the steam boiler in the carpenter's shop in the San Bernardino railroad yards. The scrap lumber was the fuel. He had that job until 1922 when the railroads got rid of the unions that they got stuck with during World War I.

Back to the first house: it was a rental, and there was a big fig tree in back. I couldn't climb to the top because the branch was about that much and I couldn't stretch enough to reach it. I wanted to get to the top of that tree. So on my sixth birthday I got up and ran out and climbed that tree, because now I was six and that darn branch was just as far away [laughter] and it was fine.

Quivik: What year were you born?

Harris: 1914.

Quivik: And what date?

Harris: October the second. I was a railroad kid at heart. My mother said that when they would come from town walking with a baby buggy, we would cross the tracks and I would start screaming. She finally figured out that I wanted to be by the railroad tracks. She could go an extra block by paralleling the tracks. As soon as she did that I stopped screaming.

I was sneaking out and going down the railroad tracks and to the railroad yards. I vaguely remember them taking me to my dad. I vaguely remember the boiler room. My mother was real concerned about me running around the tracks. They checked. My brother, my half-brother, checked the fence and everything was there. So my mother watched, and I was looking at the window, looking around. Finally I went over and I moved a picket over, went through and put the picket back. That was the end of my running away from home.

I mentioned my half-brother. He and a neighbor kid had dug a ditch and covered it with wood and then dirt, and that was their secret cave. My dad ordered wood, firewood, we heated the house with wood. The man with the load of wood and his team of horses

came along and one of his wheels [laughter] hit the boards and down it went. My brother and his friend hastily filled the hole.

Quivik: Was your brother older than you?

Harris: Yes, ten years.

Quivik: Was he your father's son or your mother's?

Harris: Mother's.

Quivik: When did your parents meet, and how did they meet?

Harris: I haven't the foggiest idea. My father, as I mentioned, he got his job--not his job, a job --back with the railroad. He was a laborer. Thirty-five cents an hour. Of course, you could get a loaf of bread for a nickel. When the people running the power plant boiler were going on vacation, my dad would get that job. So occasionally we would get a halfway decent bit of money. But I mentioned he lost his job because they went out on strike in 1922. He got a job over at the Colton cement plant.

In about 1926, the Ku Klux Klan really surged. My dad never went to church, but if you criticized the Catholic Church he'd defend it. He would not throw rocks at a Catholic church. That was his prerogative. Well, there was a big layoff. Everyone that got laid off was a Catholic, and since he argued Catholic, they figured he was. One man didn't get laid off, and he was married to the boss's daughter. My mother would drive over and get my dad when he was working there. We would be in with all the people leaving. We would see a car with the license plate frame "KIGY." That was supposed to be a secret, but everyone knew it meant "Klansman I greet you." So everyone with one of those was a KKK supporter.

Quivik: Was this a group of Klansmen in the San Bernardino area?

Harris: Yes. There were really a lot of them.

Quivik: Did they make themselves visible so that you as a child could see them in action?

Harris: Once we got sidetracked off the road and we went up. They were at a distance so you didn't know what they were saying. They were there in their white robes and burning cross and with fire and all. That was kind of spooky.

Quivik: Who were their main targets in your area?

Harris: Blacks, Jews, Catholics.

Quivik: Did your family feel any repercussions of your dad's connection, such as it was, with the Catholic Church?

Harris: No, but he had lost his job at the cement plant. My mother had bought a house. We were a couple hundred yards from the gate, one of the gates getting into the railroad yards, and all of our neighbors were railroad people, mostly. And then most of our

neighbors were strikebreakers. The union trainmen ran the trains that brought the strikebreakers that took my dad's job. When we moved from the rental house to the purchased house--

Quivik: Approximately what year was that?

Harris: It was about 1922, '21. I was going to the Mt. Vernon School, which was close to the place we rented, and my mother bought the house with her money. I remember there was kind of a long walk to the Mt. Vernon School and we switched over to the F Street School. That was a beautiful X-shaped wing, four wings, two stories and then a basement. 1884. Let's see, I'm getting onto me, and I haven't covered my mother yet.

Quivik: Yes, we'll get to her. I had a question. This would be a good time to ask what was the source of your mother's money?

Harris: I mentioned my dad was Catholic. My mother was Dutch Reform. Her folks, her ancestors were the ones that pulled a fast one on the Indians and got Manhattan Island for a few trinkets. They were the ones that the British came in, the Duke of York came in and took over New Amsterdam. Her ancestors lived in New York City. She was born in Brooklyn, which at that time I don't think was part of New York City. Her dad was a contractor and very, very honest. In those days, you couldn't get a bond protection. You just had to find someone who had a reputation of being honest and capable. And he was both. She was telling that he would just go down and write the sum of a column--they didn't have calculators then.

Her mother died when my mother was only four. Her father died when she was fourteen. She had pictures of a hospital in Brooklyn he had constructed, and then a theater, a movie theater building. He would not have built a building in which there was going to be a saloon. He had a life-long friend. My granddad put up the building and one day he went by and there was a saloon in the building. He would walk by that man that he had known for all his life as though he was a lamppost. He was very strict with himself as well, and so he was fairly well off and my mother was very bright.

The school was eight and four. The teacher was always asking my mother the solution of this and this. Finally my mother tactlessly said, "Oh you're asking me that because you really don't know." And that teacher was really uptight with my mother after that. To go to high school you had to pass a citywide set of examinations. All the people in the class but my mother got their primary school diploma. When everyone had left the teacher handed my mother her diploma and said, "If I had my way, you would never have gotten this." But it was a city exam and there was nothing she could do about it.

Quivik: You said the school was "eight and four." What do the eight and the four refer to?

Harris: Eighth grade, and then ninth grade was the first year of high school. I don't know how she met her first husband, but he was a sheet metal worker. They came west and on their way they stopped in Denver and stayed at the Brown Palace Hotel. It was the elite hotel in Denver then and a real good one now. And the amusing thing was that was the first place mother had ever run into bed bugs in a room in the Brown Palace Hotel. They came to Los Angeles and her husband ran a union shop. No one else did. So he

paid good wages, and really, the net wasn't that great. My mother finally wised up that he was liquidating her inheritance on another woman.

So she divorced him, and back in the early 20th century, that really wasn't an acceptable thing, but she had to dump him. Ironically the woman he was unloading my mother's inheritance on, she had a fellow on the side, and when the money stopped, she dumped my mother's first husband. [chuckle] Justice prevailed.

Quivik: Justice prevailed.

Harris: Yes.

Quivik: Now, what was your mother's name?

Harris: Nellie Mae Kate Hendrickson. In '36 we went back and I met her brother William Hendrickson. He had a problem with employment because, if he'd been a Democrat he would have gotten one of these government sponsored program jobs, but since he was a Republican he didn't qualify. He was a contractor too.

Quivik: And your half-brother's name?

Harris: Lester.

Quivik: Lester?

Harris: It was Crabbe, and when he graduated from high school all his records said Harris so he had his name legally changed to Harris.

Quivik: So your mother's first husband's name was Crabbe?

Harris: Yes, c-r-a-double b-e.

Quivik: And your father's name?

Harris: Edwin James Harris.

Quivik: And approximately when did your mother and father meet, and when were they married?

Harris: Before World War I in San Bernardino. Although she had a good education, high school in those days, she didn't have any training. I think my dad met her when she was working in the Harvey House. You ever heard of that?

Quivik: Is that a restaurant?

Harris: A restaurant chain, and they were located in the depots, particularly at the division points. Fred Harvey also---

[Begin Tape 1, Side B]

Quivik: You had just said that Fred Harvey also owned a chain of hotels and one was on the rim of the Grand Canyon. Was your mother working at one of the Fred Harvey restaurants at the division point in San Bernardino? And that's where your father and your mother met?

Harris: Yes. As I mentioned, my folks who live along the Santa Fe, and then in Needles, which was a day or two away from Los Angeles, because the trains didn't go too fast, and they were always having to stop and load up with water. And the man who I mentioned who became head of the Santa Fe west of Albuquerque, Pacific Coast lines, they were all out in Needles. This colored friend of ours lived there. You couldn't do too much discriminating when you lived out in a place like Needles, or you'd be talking to yourself. This colored man was a colored Mason. They had a different grand lodge. He spoke to Mr. Wall and said that I was very intelligent and that I needed the chance for education, so they hired my dad.

This colored gentleman was very interesting. The first four years of his life he was property. Because he's black he can never be a foreman, but he was the top of the non-foreman category.

Quivik: In what kind of work?

Harris: I forgot what he did, but he was working in the railroad yards.

Quivik: So when your family bought the new house, that was with money that your mother still had from her inheritance?

Harris: Yes.

Quivik: And was your father without work then?

Harris: When he left the Colton cement plant, he got a job with Parker Ice Machine Company. They made commercial refrigeration units. They had a complete setup--a foundry--and my dad worked in the foundry. The foreman at the foundry asked my mother if she wouldn't send we children to the Baptist church where he went. My mother was so happy my dad had a job, she reluctantly said yes. My dad and mother agreed that they wouldn't bother with religion. When we were adults, we could make up our own minds. They didn't want to fight over religion.

Quivik: Had your mother grown up in the church?

Harris: Yes, Dutch Reform. But there were no Dutch Reform churches in San Bernardino or in the area, so there was nothing she could go to.

Quivik: Now, you've mentioned your older brother. Did you have other siblings?

Harris: Two sisters by my dad.

Quivik: And were they younger than you?

Harris: Oh yes.

Quivik: What are their names?

Harris: Nellie, 1916. In 1919, my Aunt Etta had come up from Compton to our house. Then one day we were put outside and were just told we had to play outside, and we didn't know why we were run out of the house. My Aunt Etta came out and told us we could come in, and says, "You now have a new baby sister." [laughter]

Quivik: And what was her name?

Harris: Marjorie, and she was my dad's favorite. So Nellie and I, we didn't dare punch or hit Marjorie or we would get it. My mother, she bought a new car, a Chevrolet, in 1923. She had one driving lesson. They drove her up to Verde Mount and back, and the salesman handed her the keys. She did all the driving. My dad never learned to drive. The cars were a story.

Quivik: You say the cars were a story. What's the story?

Harris: Oh, I've forgotten why they needed another car, and they bought a secondhand Chevrolet, a '26. My dad overhauled it. Anything he touched was better off being half-broken when he got through fixing it. [laughter] He didn't get a proper gasket, head gasket, so the radiator water leaked into the cylinders. And my mother had a douche rubber bulb, and I would take out the spark plugs and suck out the water to get the car going. Finally when we came home we drained the radiator. In '36 she bought a new Chevrolet, factory delivery. In '36, my dad's railroad pass qualification enabled him to get passes for us to go to New York City. That's when I met my Uncle Will.

Quivik: By then was your dad back working with the railroad?

Harris: Yes, he went to work in 1930. No paid holidays. And Christmas and New Year--they worked two days a week--and Christmas and New Years came on Tuesday, so for half a month he only had two days pay. Between '29, the depression ruined the business and the ice machine company went broke. At one point, before he got back to the Santa Fe and before he got back to the ice machine company, one Thanksgiving we had no money and no food. Someone had given our names to the Salvation Army and the Salvation Army came and had a big basket. So we had Thanksgiving.

Quivik: Now, you said that the foreman at the ice company invited the children in your family to the Baptist church. What kind of things did you do there?

Harris: They were always after me to come to Jesus and get baptized. I didn't like being hassled, so after a few years I stopped going.

Quivik: Was that mainly to worship services they were inviting you to, or to other kinds of events?

Harris: Yes, yes. Then they had Bible--it wasn't Bible study--it was a summer program. I remember the pastor was telling we youngsters that when we ate we also took a life. He was emphasizing the loss of life of Jesus. And he said, "When you eat an egg you are

taking the life of a chick. What is it Guy?" I said, "You're not taking a life, the egg isn't fertile." And he got angry and I had to sit with the kids who were shooting spitwads, and that helped sour me on going. When we moved back to the F Street School, I did okay in the second grade. In the third grade I goofed off and they flunked me in the 3B. They had 3A, 3B then.

So when school started, I wasn't going back in the classroom with little kids, so I just goofed off, bribed my sister not to squeal on me. Old Lady Harris, the principal, she caught me, and I remember her office in the center of F Street School. She had a roll-top desk and she played a game of psychology, she let you sweat. So finally she motions to come over and she pulled out a drawer and she got her little strap out and she says, "Guy, see how red that is. I can make part of you just as red." [laughter] I knew what part she was talking about. She wanted to know why I wasn't going to class. And I said I wasn't going back to those little kids. So she gave me some tests and said, "All right, you can go start back in the fourth grade, but any trouble you're going back to those little kids. Any trouble. Back to those little kids." I was never aggressive, and I was one of the kids beat up, but my dad didn't have a gun, so I didn't shoot anybody. I empathize with that kid down in San Diego. They shouldn't be allowed to get away with it at school, because you have to go to school. My grandson went to the church school and they were taking his stuff and throwing it around and hassling him.

Quivik: Were you hassled?

Harris: Oh, yes. We lived over on the wrong side of the tracks. Next street over were the blacks, and a couple blocks beyond were the Mexicans. I felt very inferior and I wanted recognition, so I joined the Boy Scouts. I ended up with sixty-two merit badges, Eagle Scout and also the Sea Scouts, their top award. I was really crushed, one of the boys in our troupe--were you ever a scout?

Quivik: Yes.

Harris: So this kid got his picture in the paper, all this recognition, and he'd just started scouting. And when I got my Eagle, it was just there along with the first class merit badges and so on. No recognition, not even for Eagle. Then when I got quartermaster, first one in the county--Sea Scouts--no recognition. So when I got my Ph.D. I thought, ha, ha.

Quivik: Why do you think that was that you got no recognition?

Harris: My dad was just a laborer for the railroad. The boy, the star scout that got his picture in the paper, his father was dentist. Money. The scout executive, he was a crook. He had his daughter on as secretary. He paid her \$125 a month, and a good starting salary for a chemist then was \$130. Ph.D. chemists were making \$150-\$175, he was making \$225--a scout executive. He stacked the deck in his favor, because the people that were supposed to hire and supervise and control the executive, he appointed people who were just too busy. He got someone that he knew wouldn't have time to be involved but would be happy for the prestige of being on this committee or that committee.

My first job was with Shell Development. They had big laboratories set up in Emeryville. The left-wing CIO union got in, organized the technicians, several of the

chemists tried to organize the chemists. Shell never did like unions, and particularly in the research. Eventually they just shut Emeryville down and moved the people they wanted. No technician got transferred, and any chemist who was pro-union never got transferred. So I worked there a year, saved everything I could and went down to Stanford.

Quivik: Well, let's start talking about your education. Before we get to Stanford, let's go back. You went to high school in San Bernardino?

Harris: Yes. With my high school grades, there was no decent four-year school that would have taken me.

Quivik: What distracted you from studying in high school?

Harris: Oh, I couldn't be bothered. Graduated in 1932, and there were no jobs. Fortunately, there were no jobs, because if I could have gone and worked for the railroad, I would have gone and worked for the railroad and never been really that thrilled. So my mother said, "You're not going to sit on your derriere, you go over to the junior college and I'll buy the books." No tuition.

Quivik: What was the name of the junior college?

Harris: San Bernardino Valley Union Junior College, and it's now called just Valley College. Well, the president of the school had everyone take a set of tests. One battery was seeing what you've learned, and another battery was to see what mental equipment you had. So he brought it out and he said, "I can't advise you on anything, because these scores show that anything you went into you would succeed." And he called the dean of women over and he said, "Look at these fantastic scores!" [laughter] Well, I'm just saying what they said. So he asked her to get my transcript, and when she brought it over and he laid it down he said, "There must be a mistake here." And I said, "No." And he said, "With this--that's the best you could do? You should be ashamed of yourself."

So I worked a little harder. I had to go three years because no chemistry in high school, no trigonometry, and Chem 1A was required and I didn't have any background to go into it.

Quivik: By that time, did you think you were interested in going into chemistry?

Harris: Oh, yes. I loved chemistry. I could get good grades without having to work too hard. [laughter] So when I got to Berkeley--

Quivik: How did you get to Berkeley? How did you make the jump from San Bernardino community college to Berkeley?

Harris: I sent my transcript and a group of us came up in Ed Cunningham's old Dodge sedan. I remember one o'clock in the morning in Bakersfield, it was 93 degrees, and I thought, "How do they get anyone to live in this place?" Because San Bernardino would get hot in the summer, but nothing quite as bad as that. We came up to Berkeley and they had transferred 70 credits, and I remember Porter said, "Well, you didn't have organic chemistry," so he raised it from 120 to 130, the number of units I'd have to meet.

I said, "Oh, that will be no problem, because they gave me credit for 70." He said, "What? I'm raising it again." I said, "Now, just a minute, Dr. Porter. The catalogue says 120, then you raise it to 130, now you want to raise it to 140. How do I know that a couple of years from now it won't 170?" He said, "All right, 130." [laughter]

Quivik: Who was Dr. Porter?

Harris: He was one of the chem. profs. here at Berkeley. Well, I kind of goofed off. A's, B's, and D's. If I didn't give a hoot about the course, the A's would cover the grade points. I was living in a five-story old frame place behind the woman's club--it's just a parking lot now. In my junior year, still my first year here, I got interested in a graduate student. I thought, "What brass, what gall, chasing a graduate student." [chuckles] You met her. She had come over here to get her general secondary credential.

Quivik: You should tell us who she is.

Harris: Elsie Dietsch. Elsie Harris. She wasn't particularly interested in my pursuing her, [laughter] but she changed her mind. I remember I was taking the life-saving class, swimming life-saving, in gym. We had a party and she came, and I can still see her there with her bathing cap on. When I was convinced that she was interested in me--my last semester here--I made more grade points than the previous three. I got the job at Shell. After a year, I'd saved most of the money and I went down to Stanford.

Quivik: Where was Elsie from?

Harris: San Francisco State. It was a college then, and now San Francisco State University. She majored in English and Social Studies.

Quivik: And how long was your courtship?

Harris: Until I passed all exams at Stanford and I had enough money that we could afford to get married.

Quivik: So you weren't married during your graduate education?

Harris: No.

Quivik: Were you continuously courting during that period?

Harris: Oh, yes.

Quivik: What was Elsie doing?

Harris: Teaching.

Quivik: Where?

Harris: San Francisco schools. She was teaching high school, elementary, her general secondary she could have taught in junior college if they had one. She couldn't get on

permanently, because a teaching job, permanent jobs were for men, because the men had a family.

Quivik: So you worked at Shell for a year and saved your money and went to Stanford. When you graduated from the University of California here, had that been your goal all along, to go to graduate school?

Harris: No, I figured I'd better one-up Elsie. The year I was with Shell, a friend of mine was going in physics at Stanford. We went to grammar, junior high, high, junior college. Then he went to Stanford---

[Begin Tape 2, Tape A]

Quivik: You were talking about your friend who was describing the language tests. What was your friend's name?

Harris: Keith Harworth.

Quivik: And he was saying about the language exams?

Harris: He said, "Van Leisselberg is gone for the summer," so I started translating French articles from French chemical journals. When I felt it was worth a try I went down, I wasn't even a student there--and I took the French exam and passed it, so I escaped Van Leisselberg. But he got his revenge later on. When I completed my master's and the prof. I wanted to work under was back at Harvard for a year--

Quivik: Who was that?

Harris: Knoller. His textbooks were very popular.

Quivik: In which field?

Harris: Organic chemistry. When he came back I'd completed my year with Bergstrom, and I switched back to Knoller. Bergstrom was a bachelor, and--you'll laugh--there was one student named Durstine. He was a super Catholic. He wasn't very popular with any of us. He'd done some stunts on me, so I thought I'd try to water bag him, but missed. So I took a calcium chlorine can about almost a foot in diameter and a little over a foot high. The old chem. building was about as ancient as the old F Street School, and they had a sill that was about six, seven inches on the top. So I drove a nail in the door and in the sill and put a cord around the base of the can and the loop on the other end of the cord. I'd opened the door, wedged it and said, "The water should come down now!" So I made the loop and put it over the nail. The sill was just going to hold the can but the tipping thing was that nail on the door.

So I had everything ready and I waited until my prof. wouldn't be in. He didn't approve of shenanigans. So Durstine went down to get some stuff, and I have the can full of water and set it up and very gently went through the door, the opening gap, and waited. Because if my prof. should have inadvertently showed up, I was going to go through the door and take the water, because he would never blame me for doing it to myself. [laughter] But the other prof., the bachelor, came up, and I said, "Please wait, Dr.

Bergstrom, please wait.” “Why?” he says, “I want to go and talk to my students.” I said, “Please wait.” “Okay.”

And Durstine came in through the door and down came the can, the water, and when the water hit him he reflexively shot his arms out, and the door pulled the can off, and the can came down and hit him. And the prof. said, “Gee, that was worth waiting for.” Now, my prof. would not have approved of it, but Bergstrom, he was a nice guy.

Quivik: What had you studied under Bergstrom?

Harris: Heterocyclic analogs of sulfanilamide. That was the in class of antibiotics, sulfanamides.

Quivik: Sulfa drugs?

Harris: Yes, sulfa drugs.

Quivik: While you were at Stanford, do you remember a man named R.E. Swain?

Harris: Swain?

Quivik: Yes. What do you remember about him?

Harris: We had, I forgot the nickname now, but we had an uncomplimentary nickname for him. There was a student who got his master's at the same time as I did, also under Bergstrom. He had graduated from college when he was seventeen and he got a write-up in *Time* magazine. He said, “Oh the professors nowadays, they don't know how to write.” So there were some profs. who read that article, and they weren't thrilled. His thesis, master's, was a big thick thing, and we had a Chinese fellow who got his bachelor's in the University of Canton and his Ph.D. at the University of Heidelberg. And he said, “Did you see that? Friedberg's thesis? It reads like, what do you call, a funny book, a comic book.” Well, poor Bergstrom, signed and approved it. The faculty, not just him, broad context faculty, disapproved it. He had to rewrite it and get it rebound. We had been invited over for Edgar's birthday--

Quivik: Edgar who?

Harris: Friedberg, this Jewish student. I had never been to a place where they have servants and they waited on you, but it was a nice dinner for his birthday. Well Mama, the Jewish mother, disapproved of the way they treated her son. So she came, went in to see Swain and expressed her strong disapproval. Stinky, we called him, Swain. Swain was listening to her and she said, “And if I can't be assured that this sort of thing will never happen again, I will take my son out of your department.” And Swain said, “I believe that can be arranged, Mrs. Friedberg.” And she stormed out. They drove up in a big limousine, chauffeur driven. Mama came in first, Daddy followed. When she stormed out, Papa followed her out, and they got in the car and they drove off. He went on and moved over to the education department.

Quivik: Do you remember why Swain had the nickname of Stinky?

- Harris: He was never real popular with the students. He was always after me. I only had six units of German. He was always after me to sign up for German classes, because I was a teaching assistant and I just paid by the unit. He wanted to increase the number of units more. Oh, and lower classes often drew premium tuition. He was after the money. I kept stalling. Finally, he did the counseling, he said, "Well, Mr. Harris, you put off taking that German class just long enough." I said, "Why do I have to take it?" He said, "Well, you have to pass the language requirement." I said, "Well, I already passed it." [laughter]
- Quivik: The French?
- Harris: The German.
- Quivik: The German as well?
- Harris: Yes. So I saved myself some money.
- Quivik: Was Swain the head of the entire chemistry department?
- Harris: Yes.
- Quivik: Do you recall, was he responsible for raising money to enhance the research facilities there at Stanford?
- Harris: I don't remember. I know that he was a consultant about the smelter fumes that went from Montana over into Canada in the big international thing. He was the consultant.
- Quivik: Trail, British Columbia?
- Harris: Yes. Oh, you remember better than I do. [laughter]
- Quivik: Did he have students helping him with that case?
- Harris: I don't know. That was before I went there.
- Quivik: And Knoller, what do you remember about him?
- Harris: [mimics Knoller yelling out] "Harris! I want to see you in my office!" When I finished my master's, I had a teaching assistantship, both winter and spring quarter. Fall quarter I had enough money for the tuition, but then I wouldn't have money for room rent or food. So I applied for a tuition loan, and the man called me and we had to fill out a form what our living expenses was. He said, "I want an honest one." I could have spit on him. He said no one can live as cheaply. I was. But his folks probably had money. He never had to scrounge. I was so mad I went and paid the tuition. And this thing worked out. Knoller called me in his office. He said, "Harris, it's all right for graduate students to correct undergraduate classes, but not graduate classes." And he said, "You know I'm on two or three committees this quarter, and I just won't have time to correct the graduate organic. You will correct." I had the money--I was able to pay my rent. [laughter] And then I was teaching assistant one term working for Bergstrom and another for Knoller.

Quivik: Did you work during the summers away from the university, or did you work at the university, and were you able to earn an income during the summer?

Harris: No, I had my master's and I had enough money to carry me through the summer, but then the fall term that was a big problem. For the last year I had a research assistantship and also got a scholarship. After the first year we had to take a battery of tests, and Van Leisselberg had the physical chemistry. I made a 96 on mine and he gave me a B. He got his revenge, [laughter] inadvertently. Then we had to minor in something, and I minored in physics. I had taken several classes, physics classes at Stanford, and one of the classes, thermodynamics, was taught by Felix Block, who got a Nobel prize. He passed me in the hall, a total stranger. The physics department, a quarter or two before I was ready, started giving three half-hour oral sessions, two profs., two and two. So an hour and a half. Half of it the main three-hour university oral. They were flunking two-thirds to three-quarters of all the ones taking it. One math instructor flunked four times and they told him, don't come back. Math instructor!

And here I was, an organic chemist venturing in there with all the math that you get in physics. My friend had tipped me off about a lot of the trick questions. Five of the guys wanted to okay me, and a fellow from Switzerland wouldn't budge. So I was one of the majority. Next quarter, he wasn't there. I passed. I was one of the minority who passed. One fellow from physical chemistry, they flunked him. So I felt pretty good.

Quivik: Was this your friend from San Bernardino that tipped you off on the trick questions?

Harris: Yes.

Quivik: Do you remember the name of the Swiss professor?

Harris: Not at the moment.

Quivik: What was the topic of your dissertation?

Harris: Which one?

Quivik: For your Ph.D.

Harris: The interrelationship between kaio-cystic acid to other tri-terpenoids. Tri-terpenoids are a group of C₃₀ pentacycline compounds obtained from plant sources. The si-kaio-cystic acid was obtained from a kaio-cystis wild cucumber vine that grows along the coast. I did okay. Publications were scarce in those days, not like today. The Phi Beta Kappa that worked next to me had one paper, I had three. The prof., Knoller, called me in his office and he said, "I want this, this, this, this. When you're done you can start writing your thesis." Because I was leaving soon. "By the way, you can continue to goof off the way you have been and be here a couple more years." [laughter] Six weeks, I had it all done. If he had known how fast I would get it done, he would have given me a longer list.

Quivik: Now, was your thesis project part of a larger research project that Knoller was engaged in?

Harris: Oh yes.

Quivik: What was his overall project, what was he working on?

Harris: Trying to interrelate--the tri-terpenoids are different groups, and he was trying to relate the kaio-cystic acids to beta-amaron which he felt had the same structure except functional group difference.

Quivik: And was his work, and by extension your work, being done to advance the theoretical knowledge of tri-terpenoids, or was there an application for this work?

Harris: No, no application. Yes, there was an application. I asked him what the utility of it. "Oh, it's a good project to train Ph.D.'s." [laughter] Quote. The three-hour oral, your name went on the bulletin board all around the campus. Any prof. could come in and ask you anything. English, foreign language, whatever. But they didn't because if they started doing that, Knoller and Bergstrom would show up at theirs and flunk theirs. So the one man to represent the physics department was the Swiss. God, I wanted to walk out, but Knoller is a lot like [Douglas] Fuerstenau, and you just don't do that. I held my own with him until the last.

The chairman was from the English department. He said, "Well, you have a hole through there and it goes through the other side and you drop a ball. What happens?" I said, "It goes down almost to the other side and comes back and oscillates back and forth and comes to rest at the center." "Yah, yah, write zer differential equations for the motion." I said, "Well, do the gravitational one, that's easiest." He said, "It's like the charge on a sphere." I said, "The charge is on the surface, it seems like it is in the center." I was so shook, I couldn't even think. [imitating another person:] "The physics department time is up!"

Quivik: And who said that?

Harris: The fellow from the English department. The man from the biochem department was asking me a question on stereo chemistry and I answered him. I knew the answer. But apparently I didn't make it clear enough to him, so he led me though. I thought, "Oh well, this is going to use up a lot of the time, and maybe someone else's nasty question, there won't be time for it." And Knoller, he would always have his students come in after they had completed that, and God help you if you didn't pass. He said, "Well, you passed, but I noticed you had a little trouble with Loring's question on stereo chemistry." He said, "I guess you didn't take my class." And I said, "Oh, I took your class," and he said, "Well, what did you get?" And I said, "An A." He said, "[growl sound]." [laughter]

The last year I passed that oral, so all I did was write a thesis. I knew that as far as a Ph.D. was concerned I had it made, because there were a few guys that didn't pass their main oral and had to take it over a again.

Quivik: What year did you finish your Ph.D. then?

Harris: Nineteen forty-one.

Quivik: Early or late?

Harris: The summer.

Quivik: And the oral was earlier in '41?

Harris: Yes, yes. We, Elsie and I, rented some small rooms and a large bedroom surrounding the car garage, and we had Bergstrom over for dinner.

Quivik: Were you married by then?

Harris: Yes, yes.

Quivik: When did you get married?

Harris: Nineteen forty-one.

Quivik: What month?

Harris: I think March.

Quivik: So does that mean you are about to celebrate your sixtieth anniversary?

Harris: We did.

Quivik: When?

Harris: Last April.

Quivik: Aha. So that would be married in--

Harris: Sixty?

Quivik: Yes.

Harris: Sixty from 1940.

Quivik: You were married in 1940, okay, a year before you finished your Ph.D.?

Harris: Yes.

Quivik: And where were you living when you finished? Palo Alto?

Harris: Menlo Park. That was lucky, because if I'd been in the Palo Alto draft board, I might have been drafted, but I had a teaching job, Mercy College. It was a school set up, licensed by the state, run by the Sisters of Mercy, and the only students they took were their nuns.

Quivik: Was that in Menlo Park?

Harris: In Burlingame. It paid good money. Twice what I was making as a research assistant. The landlady knew that I had my master's, and her daughter who became a nun had gone to Mercy High School. She knew they were looking for someone to teach a class, a chemistry class for the nuns. In those days, if you weren't completely through, what do you call novitiate, in transit, you couldn't go out in public to school. So they had to run their own program.

Quivik: There were nuns who were training to teach at parochial schools?

Harris: Nurses. A couple of them had their R.N. but they wanted them to get their bachelor of science.

Quivik: And were you teaching at Mercy College?

Harris: Mercy College, but the class was held at their--

[Interview 2: June 7, 2001] [Begin Tape 3, Side A]

Quivik: This is Fred Quivik, and I'm interviewing Guy Harris for the Regional Oral History Office at the Bancroft Library. We're in the press room at the Bancroft Library. It's June 7, 2001. Good morning, Guy.

Harris: Good morning, Fredric.

Quivik: We're continuing with your discussion of your teaching at Mercy College. When we left off last time, you were talking about how they wanted to be able to train the nuns inside Mercy College before they took their vows, and before they sent them out in the world to be teachers.

Harris: R.N.'s.

Quivik: That's right, R.N.'s, nurses. Can you describe a little bit about the teaching environment at Mercy College?

Harris: I think I mentioned, the first day they all stood up. I thought, "Gosh the mother superior is coming." I looked behind me, and no one was there, and they were laughing and said, "Good afternoon, Mr. Harris." Every day I would come in, and class would start, and they would all stand up for me. The only time I've had any classes do that for me! They had lab equipment from the high school there. The equipment was quite adequate. There were two units organic, two units inorganic, and two units of biochem. I had never had a biochem class in my life, but I can read the textbook and keep ahead of the women.

Quivik: How many students did you have in your class?

Harris: Five, I was telling you there were two left, and now there's one.

Quivik: So you kept in touch with those nuns over the years?

Harris: Sister Alice, I got reacquainted with her when my wife was over at St. Mary's hospital, for a hip replacement. I was telling one of the nuns that I used to "work for you gals." She said, [high-pitched imitation] "Here?" I said, "No, down in Birmingham." She wanted to know what I was doing, and I told her. She said, "Sister Alice is still here, she's on the staff." That's how I got to get reacquainted with Sister Alice. When we're having lunch, she'll motion for somebody to come over and say, "This is my professor," and I say, "Yes, in 1941." She said, "He was a fantastic teacher. In high school I only got a D in Chemistry." I said, "Well, Alice got an A minus in Chemistry, and I don't grade easy." She mentioned to me, a month or two back, that Sister Mary Bartholemew had passed on.

Quivik: Sister Mary was another one of your students?

Harris: Yes.

Quivik: Did St. Mary's College offer a full slate of courses that were preparation for nursing training?

Harris: I don't know what they did. I was married then, so it was safe to have a man. [laughter]

Quivik: Did you know any of the other faculty, or did you just go in and teach your class?

Harris: Yes.

Quivik: Do you happen to know where they did their nursing training?

Harris: Most of it what was probably done at USF.

Quivik: So you only taught at Mercy College that one year?

Harris: One semester.

Quivik: One semester, so you taught those three courses.

Harris: The class consisted of those units, two, and two, and two. I think I mentioned that I ran out of money. I had just enough money to pay my tuition at Stanford, but not enough to eat or get a room. My professor called me in, and said that he was going to be awfully busy that quarter. He had to be on some committees. He mentioned that he didn't believe in graduate students correcting papers for graduate courses. He said he was going to be busy, and that I would correct the papers for the graduate organic chemistry class.

I had applied for a tuition loan. We had to fill out a form, and I turned my form in. The guy called me in and said, "No one can live so cheaply, I want an honest evaluation of your expenses." I was so mad, I figured he was just a--. My dad was on the bottom rung, and this fellow, no doubt, had a middle class father. I was living that cheaply, and he couldn't have because he lived too high on the hog.

I was serious, so I took all my money and paid the tuition. I didn't know how I was going to get by, but when Professor Knoller called me in and said I would correct papers, I'd be able to pay my rent. I did have a teaching assistantship the winter and spring term. And lastly, I had a research assistantship so my last quarter I had a scholarship that paid the tuition.

Quivik: Last time we talked about you and Elsie being married in 1940, and then you finished up your thesis in 1941. Then you were ready to go to work outside the university?

Harris: Yes, the American Chemical Society had an employment clearinghouse at their meeting, so I went back to Atlantic City at an ACS meeting and I paid my way. Things are different today, much better for the students. I took the train back, and a Jewish friend of mine and I went bathing in the surf at Atlantic City the last day we were there. He asked me how many interviews I got, and it was either six or seven and he said, "Oh, you did pretty well." He had talked to a guy who got ten or eleven, but he said "You did pretty well when they consider that you're a 'whiff.'" And I said, "What?" He said

"Whiff." I said, "But I'm not Jewish," and he said, "I know it, you know it, but they don't."

A lot of Jews had the name Harris, and they looked at the picture so they wouldn't give interviews to blacks. I stated that I was Protestant. I wasn't, but in those days if you weren't a Jew or a Catholic, you were a Protestant! [laughter] No matter if you never went to church! He said, "They think that you are Jewish, and they think 'Another kike' and turn the page over." But I did get a job in Cincinnati. My wife had enough money, and we bought a new car and loaded it up. Alice was in the back seat on top of all of the things we were taking with us.

Quivik: You better tell us who Alice is.

Harris: Alice is the first of my four children. We drove down, and I wanted to say goodbye to my parents and some of my friends that had been kind to me. We drove on to Needles. The old highway went up through the hills and came down a real twisty roadway. There was a little town there, and I was so tired that we stopped. Fortunately we did, because further on the next morning we could see a lot of auto wrecks, where people had gone off the road because it was so tortuous. We went on to Amarillo, Texas. The roads had been flooded over. We went out to see a friend in Bartlettville, and one of the rivers had overflowed and probably all the rivers in that area overflowed. We came through Illinois and Indiana, and on to Cincinnati.

Quivik: What time of year was this?

Harris: October.

Quivik: Of 1941?

Harris: Yes, just before Pearl Harbor.

Quivik: Do you remember what kind of car you bought?

Harris: It was a Mercury.

Quivik: Who did you get a job with in Cincinnati?

Harris: William S. Merrill Co., founded 1829.

Quivik: And what did William S. Merrill Co. do?

Harris: Pharmaceuticals. They were eventually bought out by Dow. Dow sold them off, along with the rest of their pharmaceutical ventures, off to the Germans.

Back to my research work at Stanford, I got three publications out of my research work, which was rare in those days. Now, they publish--. All you have to do is look at back in 1940. Chem Abstracts didn't take a lot of space on the shelf. Now just one year fills a shelf. And I got a couple of papers out of the work at Merrill.

Quivik: These were in addition to the papers that you got out of your Stanford research. Did Merrill encourage its employees to publish?

Harris: Only after the patent is issued. My first patent came at Dow.

Quivik: What were you doing at Merrill?

Harris: Synthesis work with drugs. I synthesized 155 germicides. Peridinium, alcium, peridinium nalides, perpediniums. They wanted that work done, and it wasn't considered really essential as far as the war effort was concerned. I was a pre-Pearl Harbor father, so they unloaded all that on me. They wanted it done, but they didn't want to have any of their people drafted. They knew I was safe from the draft.

Quivik: What made you safe from the draft?

Harris: Pre-Pearl Harbor father.

Quivik: That was the key?

Harris: Also, I registered in Menlo Park, and they didn't have a lot of college graduates on their availability list. Whereas if I had been in Palo Alto, I would have been one of many highly eligible draftees.

Quivik: Let's go back for just a bit to the work that you did between your being at UC and Stanford. What kind of work did you do at Shell?

Harris: Did I mention the fact that of the eighty-six graduates from the College of Chemistry, only a dozen got jobs or went on to graduate work?

Quivik: No.

Harris: I was fortunate to get a job with Shell. I worked in their analytical lab.

Quivik: Where was that located?

Harris: Emeryville. They had a problem with the Communist union that had organized the technicians, and several of the chemists signed up for that union. I didn't, I had always been on the conservative side.

Quivik: Do you remember the name of the union?

Harris: No, the leaders were Marxist and that's all I can remember.

Quivik: What was the analytical lab working on? What part of Shell's operation was this?

Harris: They had a big research center there. Even at Dow, I did my work, had it done in the analytical department.

Quivik: And that's what you were doing at Shell, working in the analytical department?

- Harris: Yes, we were distilling hydrocarbon fractions at atmospheric pressure. We used liquid air to condense the gases and keep the material in the distillation column in the liquid phase. We got the liquid oxygen from the Shell plant in West Pittsburg. We pressed something, and it would squirt the liquid oxygen through the head of the column. That way, we would keep the material in the column in the liquid phase.
- Quivik: Was this all analytical work being done for Shell's plant in West Pittsburg?
- Harris: No, Shell Research, Shell Development it was called.
- Quivik: Do you remember what kinds of things Shell was trying to develop there?
- Harris: They developed a lot of good processes. One of the comments the Shell people made was that you sure could tell when a Shell patent expired, because the next day Dow would cut the ribbon on their new plant. They wouldn't have to pay any royalties because the patent expired.
- Quivik: Can you tell me what kind of industry this was? Was it strictly related to oil products?
- Harris: Well, take for example, al-chloride is not a product that you get out of crude oil. It has to be synthesized. They got it by chlorination of propylene. The propylene came from the crude oil.
- Quivik: What were these synthesized products being used for in the 1930s?
- Harris: For one thing, insecticides, and today they're interested in polymers.
- Quivik: Back to Merrill, you worked at Merrill for how long?
- Harris: Three and a half years.
- Quivik: Where did you live when you were in Cincinnati?
- Harris: In an apartment in Cincinnati. I was a prankster, do you want to hear about that?
- Quivik: Yes.
- Harris: Bill Corbett, the librarian hated Bill Corbett. Because of the war, rubber was at a premium. So you would use Tygon tubing, and you would run water through a column you'd use a short section of rubber and then Tygon and then a short section connecting to the condenser. This Tygon was yellowish. You would cut off a piece, and then when you trimmed it for the rubber you would often end up with a crescent-shaped little piece. I made several of those little pieces and put them on the librarian's desk. She was poking at them on her desk and asked, "What's going on here?" I didn't say they were nail trimmings, but I said that Corbett was trimming his nails. "OUT! Dr. Harris, OUT And don't come back!" I had to use the library an hour or so later, and I came in. "OUT, OUT!" And I said, "Helen, please, just give me a minute, will you?" I took a piece of Tygon and cut it off, and she said, "Dr. Harris, you're impossible!"
- Quivik: This was the library at Merrill?

Harris: Yes. Another story. I bought some life insurance, because I thought my wife needed some protection. I told my friend, "Hey, you ought to get some life insurance." "Oh no..." And I said, "I'll send the agent to your house." He said, "You wouldn't dare." So I had a phoney-baloney conversation on the phone with an insurance agent. I even had one of my co-workers, farther down the ladder, make calls, pretending to be a life insurance agent, like with New York Life. The next day my friend told me he had been out the night before, so I volunteered to send another agent by his house. He said, "Harris, you're an old bastard!" [laughter]

I had to get used to driving in the snow. We also had a victory garden.

Quivik: Did you work in the garden, or was that mainly Elsie's work?

Harris: Both.

Quivik: What kinds of things did you like to grow?

Harris: Oh, tomatoes and string beans. The usual things.

Quivik: You described how you were able to stay out of the draft and your victory garden. Can you think of some ways that the war changed the way work was being done at Merrill?

Harris: Yes, we were making atropin, that's a yellow-colored anti-malarial. We manufactured that, did quality control, and so on. If someone was really having a problem with the draft, we had them work on the anti-malarial so that they could make a big ado about the anti-malarial. They had to have something to protect the soldiers from malaria.

Quivik: So working on anti-malarial drugs was considered an essential job for domestic industry?

Harris: On one of my trips back to Cincinnati--. My boss had a sense of humor, too. [laughter] He introduced me to a new Ph.D. they had hired. Her job was to do literature work and write reports. He introduced me to her and she asked my real name. I said, "Guy Harris." She said, "No, that's just another one of Van Kampen's jokes." So I got out my driver's license and she said, "My God, you're real!" So then I began to wonder what Van Kampen had said about me. Were the stories true? Or were there embellishments? I couldn't complain, because I had been guilty of that, myself.

Quivik: What year was that you took that trip to Cincinnati?

Harris: It was in '55 or '56.

Quivik: 1945 was when your employment at Merrill ended. What happened next, and how did it come to pass?

Harris: I ended up working for Padco. They had a plant down in Emeryville that manufactured roofing, flooring, and paints. They had a subsidiary that did work, called Plant Rubber and Asbestos.

Quivik: Why did you leave Merrill?

Harris: Oh, my wife, and her mother had come to live with us, always complained about the weather. I got so fed-up with their complaints, I decided to come back out to California. I liked the work there at Merrill. But, as I say, I just got fed up with their complaints about the weather.

Quivik: How did you find the job at Padco?

Harris: Through an interview. I was there for one year and five months. After one year, all of the technical people who didn't belong to the union had to join. The union said that they would shut the plant down. After five months being in the union, I ended up at Dow.

Quivik: Was it difficult to change jobs during the war, when you went from Merrill to Padco?

Harris: Things had gotten easy. I had applied for a commission in the navy, and they weren't interested in my Ph.D., they were interested in my equivalent of a bachelor's degree in physics. They wanted people to look after radar equipment.

Quivik: Did you quit Merrill before you went to Padco, or were you hired before you quit Merrill?

Harris: I had the job and then I came out. I quit Merrill later.

Quivik: Was it while you were working at Merrill that you applied for the Navy commission.

Harris: Yes, but my eyesight was just a little shy.

Quivik: What kind of work did you do at Padco?

Harris: Oh, making new products in flooring. Dow had a new flotation reagent. Cornelius Keller, inventor of xanthates, that's flotation reagents, had the patent and licensed it to Dow. They had problems making it, and at Merrill I had a reputation for being a troubleshooter in their processing plant. So I think that got me the job at Dow.

In those days, if you applied for a job, they wouldn't hire you unless you had quit or had the company's consent. You were property. I didn't realize it, but they had asked me, when they interviewed me at Dow, if I had talked to management at Padco. They asked, "Do you mind if we do?" and I said, "no," not thinking they would. But they had to. Now, chemists aren't property, they don't have to get the company's consent or quit. But back in the forties, yes.

Quivik: Can you describe the products that Padco made?

Harris: They had a variety of paints. We could get a discount, and I had a friend who had done a lot of work on their paints. I asked if any of their stuff was worth buying, he said that some of it was. He gave me the code numbers, and I got that. A Santa Fe train-man lived across from us in Richmond. He rented and painted the house, but the landlord bought the cheap stuff. But I bought the good stuff because I didn't want to re-paint in a hurry.

Quivik: Both of them were Padco products? The cheap and the good stuff?

- Harris: Yes. For seven years I drove on Highway 4 through Franklin Canyon to Dow. We lived in Richmond.
- Quivik: Let's finish up with Padco. Did you live in Richmond while you were working at Padco as well?
- Harris: Yes.
- Quivik: But that was just over a year. They made paints and--?
- Harris: --flooring. Linoleum is non-existent now. But in those days, they would get unsaturated vegetable oils and they would blow air through it. When it got viscous enough, they'd make flooring out of it. They would add inorganic solids to it, to color it, to make linoleum.
- Quivik: And you said something about asbestos?
- Harris: Yes, we also made insulation.
- Quivik: For pipes and that sort of stuff? Were you involved with all that?
- Harris: No, thank goodness.
- Quivik: As a chemist in the mid-forties, were you aware of the health hazards of asbestos? Were you aware of any kinds of precautions that Padco took when dealing with asbestos?
- Harris: They didn't.
- Quivik: So it was later that the awareness of the asbestos hazard came along. What was your job at Padco?
- Harris: I worked on improving linoleum.
- Quivik: Again, analytical kind of work. Were you trying to come up with new chemicals for the production process?
- Harris: Yes.
- Quivik: Were you there long enough to have any successes?
- Harris: No. They didn't need my ideas, and I wasn't that thrilled working for them because I like ideas.
- Quivik: When you were showing me photos at your house, you showed me a photo of a boiler explosion at Padco?
- Harris: No, that was at Merrill.
- Quivik: Do you recall anything noteworthy about that event?

Harris: It was probably ether or another highly volatile material with a low boiling point. Just as in a household, if the natural gas has a leak and builds up to the explosive limit, and you get a spark, you'll have an explosion.

Quivik: It wasn't an accident that affected you directly?

Harris: No. I did work with ceto-methylol chloride, a germicide that they manufactured there, had to meet certain specs. One of the specs was the chloride analysis. My friend in charge of the manufacturing had several batches there. They didn't meet the chloride specs, but they were effective as germicide. Some assays were low, and some were high. I got thinking, and I said, "Alan, take this batch, two-thirds of this batch, and re-crystallize them. When they re-crystallize, the chloride wouldn't change." So he did, and gosh, it matched the specifications. That led him to mix the right amount in the batches. He asked, "What's the secret?" So, I finally told him, and he was able to get rid of most of the stuff there that didn't pass these specifications.

Quivik: That's the kind of "idea" work that you enjoyed at Merrill, that you missed at Padco?

Harris: Yes.

Quivik: What became of Padco?

Harris: They never showed any ingenuity. They weren't interested in vinyl tiles. One of the men poked around a little bit with it. Of course the plant rubber and asbestos section went down the tube with the cancer scare. Justifiably. And there are all sorts of paint companies. They just got lost in the shuffle.

Quivik: Now we'll turn our attention to Dow. You described how they had to contact Padco to let you work for them. Did they seek you out or did you apply there for a job? Were you looking to change?

Harris: Oh, yes, I wanted a change. I wanted to get out of that union. I wanted to get in with some more interesting work.

Quivik: Did you feel like the union was cramping your work style at Padco? Or did you just not like being in a union?

Harris: One of the Ph.D.'s, a chemist, was a Communist. He had a party card. We had to go to the damn meetings, or we got fined. We had elections for union officers. This Communist was the only candidate for president. So I talked to one of the non-Communist fellows and he said, "Well, if I'm nominated and elected, I will serve, but I won't seek the nomination." That's all I needed. I got all the straight guys to make sure they were going to show up. I had someone nominate the right fellow, and so at the union meeting they presented the slate. He was nominated and the Communist guy said he didn't want to create any disharmony. I said, "You gotta run, you gotta run, we're for you!" What a fat lie! I think it was 35 to 6 in favor of my man.

Quivik: Was this the same union that had tried to organize at Shell?

Harris: Yes.

- Quivik: Do you know when in your growing up you recognized that you were a conservative and not in favor of unions?
- Harris: My first vote for president was in 1936 when I was up here going to Cal. I voted for FDR. The third term I was for Willkie. But Willkie was trying to out-do Roosevelt, so I ended up voting for Norman Thomas. I felt at least he was honest. The fourth term I voted for the attorney general of the state of New York.
- Quivik: Who was that?
- Harris: I don't recall. He ran a second time, and the press had him winning the election and Truman won. It wasn't Willkie.
- Quivik: No, and I can't remember the name. Your family was a railroad family, did your family have union ties?
- Harris: My dad belonged to the union in 1922. The railroads wanted to get rid of the unions, but they got stuck with them during WW1. There was a nationwide strike, and the unions lost. My dad didn't have to belong to the union, but he wanted to be a good guy and did. He had a good job, and he lost it. We had financial problems after that. He had a couple jobs after that.
- Quivik: I'm most interested in the union part of it. Did you grow up being an advocate of unions as a child?
- Harris: Yes, but the union leaders had been bought off by the railroad. I didn't think too much of them. My brother was a union man, he was a motion picture projectionist. I remember doing some electric wiring for him. I said, "Well, Barney," that was his nickname, "this is a union job so you'll have to get a union carpenter," and the union and electrician would sit there collecting his union pay. I did it for free, and my brother was happy to get a free job.
- Quivik: Were you unhappy with the Padco union because of its leftist leanings, or because it was a union in general?
- Harris: Oh, leftist! I wasn't too happy being in the union but a commie union was just too much.
- Quivik: At Dow, there was no union to affiliate with?
- Harris: The plant workers were unionized.
- Quivik: But not the chemists?
- Harris: Not even the lab techs. The gal who washed the glassware belonged to the union.
- Quivik: Can you describe the organization of Dow at the time? What division were you in, and how did that relate to the larger corporation?
- Harris: In 1937, Dow bought out the Great Western Electro-Chemical Company, primarily to get their patents. Great Western had a process for chlorinating methane and making

ethyl chloride, methylene chloride, chloroform, and carbon tet. They had some other patents for making al-chloride.

[Being Tape 4, Side A]

Quivik: Guy, you named some chemicals for which Great Western had patents for how to produce them. Could you repeat that list?

Harris: Methyl chloride, methylene chloride, tri-chloro-methane, chloroform, and carbon tetrachloride. I think they also had done something on processing al-chloride and ethylene chloride and [sounds like] vanilla-bean chloride. Also C1, C2, and 3C hydrocarbons they had worked on chlorinating.

Quivik: At Great Western, did they use electricity in processing those chemicals?

Harris: Yes, they'd take salt solutions and electrolyze them and make them caustic in chlorine. In the cell house, they also used mercury cells to make potassium hydroxide.

Quivik: Was this a production facility or a test facility?

Harris: Production.

Quivik: Where was that located?

Harris: Pittsburg.

Quivik: Was the entire Great Western operation in one location there?

Harris: They had been making xanthates by an old process. Their xanthates were called "Bear" brand. When I came, research was developing a process, a good process for making the xanthates. They also were making an agent called benzamine. It was really amyl benzyl thiocarbonate. The company that had the xanthate patents,--well, when the patents expired they just folded up the company. They had research labs in San Francisco. The name of the company escapes me.

Quivik: Was it Mineral Separation?

Harris: Yes. North America. They made big bucks off their xanthate patents, and Keller felt that they really short changed him, so he kept this benzamine patent under his hat. He kept it off his resume until he wasn't working for the Mineral Separation company. He licensed it to Dow. They would take methane chloride, which was just the solvent or dispersant, ammonium thiocyanate, benzyl chloride, and a secondary amyl alcohol, and they thought they were getting di-ethyl carbonol. The company that made amyl alcohol from the chlorination of pentane, and then saponifying it, ionizing it with caustic soda.

I was working with this reagent. I bought pure di-methyl carbonol from Eastman. That's pentanol 3, and I got some pure pentanol 2 and I made a reagent. They were solids. I washed, had water to get rid of the ammonium chloride and then get rid of the methylene chloride, leaving pure product. Both the pentanol 2 and 3 were solids.

Things can be super cool, and you think you have a liquid product. But all it takes is one crystal, and the whole thing sets up.

But I had pentanol 2 product and 3 product, and each dissolved. So I knew that the stuff I was buying wasn't pure. At that time infrared spectroscopy had just come in, and they analyzed my pure stuff and were able to determine that about 2/3 of one of the two wasn't pure. So I went down and said, "Hey, what the hell, your di-ethyl carbonol isn't pure." They were hemming and hawing. They were selling the same stuff as mixed amyl alcohol, or so-called pure stuff! The same stuff! But at almost twice the price. We got the process really going quite well. But no one had ever taken the trouble to analyze the cost. So we found out the more we sold, the more money we lost. [laughter]

Quivik: What were you selling? What was the product in that particular instance?

Harris: Secondary amyl benzyl thiocarbonate.

Quivik: What was that chemical used for, who bought that?

Harris: It was a good flotation reagent. Far better than the xanthate. I had made some isopropyl methyl thiocarbonate, and it was even better than the benzamine. They were losing money. If they charged enough to make a profit it would have been too expensive, so they switched over to the Z200, which was, instead of ethylene we used methylene.

Quivik: That's the reagent that you patented, right? When you first went to work at Dow, were you working on these reagents?

Harris: No, I was involved with the new xanthate process plan. For Dow xanthate process, they would take powdered cilium hydroxide or potassium hydroxide, and suspended it in pentane. They chose pentane because you can't get a reaction mixture with a higher temperature than 36 degrees. They had a condenser to condense the pentane so the heat of the reaction would be unloaded onto the condensers, and the pentane would carry the load.

Quivik: Was that 36 degrees Celsius?

Harris: Yes.

Quivik: When you say, "the new Dow xanthate process," was this a process that Great Western had developed? Or was this after Dow acquired Great Western?

Harris: Yes.

Quivik: Did Great Western have any facilities besides the one in Pittsburg?

Harris: No.

Quivik: Did Dow have any operations in the Bay Area before that?

Harris: No.

- Quivik: So that company became part of Dow, but did it continue to operate with many of the same managers and so on?
- Harris: Yes, our research director was Hirshkind. He got his Ph.D. under Haber, who had developed the ammonia process.
- Quivik: Where?
- Harris: Germany.
- Quivik: That's where he got his Ph.D.?
- Harris: Yes, he was brought up in Germany. He was very reluctant to hire any Jews, because he didn't want to be accused of being pro-Jewish.
- Quivik: Did Dow have a group of chemists working on xanthates already by the time you arrived?
- Harris: Yes, they were doing a good job working on the xanthate process. They were making the benzimate.
- Quivik: Were these all Great Western folks who came with the acquisition?
- Harris: Most of them had been hired after Dow took over the plant. It was '37 when Dow took over, and I went to work in '46.
- Quivik: So you entered a team that had been working on the xanthates for some time? What was your first task?
- Harris: Primarily the benzimate, and I was making derivatives. I got pure alcohol and products were solids.
- Quivik: What was the name of the group of researchers you were working with? Did it have a name?
- Harris: Dow had bought up the lab from Mineral Separation in San Francisco, and they went out to Pittsburgh.
- Quivik: So they bought that lab and many of those people. Was that just after you started to work at Dow?
- Harris: Yes, a year after. They were working on the new building when I went to work for them. My lab bench was on "two by twelves" on sawhorses. Then the new building had conventional lab benches. Before then, it was very inelegant.
- Quivik: I gather that this Great Western division was producing a variety of chemicals, of which some were reagents for the mining industry, but they produced a lot of other kinds of chemicals as well.

- Harris: Yes, they had an ammonia plant. They were using the hydrogen from the electrolytic cells, to combine with the nitrogen to make ammonia.
- Quivik: And you were in a research group. Did this research group apply its efforts to any and all of the chemicals that Dow was producing?
- Harris: Yes.
- Quivik: So it wasn't a group just working on reagents. You could have been working on anything. You just happened to fall into the reagent research?
- Harris: Yes.
- Quivik: As background, can you describe what a reagent is? But first, go back further. Could you describe flotation technology? What is flotation?
- Harris: A typical copper ore will contain 0.6 or 0.7% copper. There are better ores, but that's a typical ore. The big boulders are brought in and crushed. Then they are ground in either a ball mill or a rod mill. Then it goes into the classifier and the fine stuff goes on to a flotation cell. If it's too coarse, it goes back for another bash in the rod mill or ball mill. In a flotation cell, the reagents are a frother, not a foamer. They blow air from the bottom, and it is agitated. This goes down a bank of cells.
- Quivik: We should add that all of the ore is in a slurry with water.
- Harris: In this slurry, they blow air, and they have a frother. Then they add, what we call collectors. The collector doesn't adsorb onto the gangue mineral. It adsorbs onto the good mineral. That makes the copper particles more hydrophobic. Hydrophobic material will latch on to the bubbles. The rest of the ore is hydrophilic and stays suspended, and goes on out the end of the cell bank. As the bubble comes up, the froth spills over to the side, and falls down into a trough. The froth breaks down, and this good mineral is carried by the water flow and the good ore is processed. You have percent-recovery that's in the mid-90s. The good stuff is separated or recovered. The other 98 or 99 percent goes out on the tailing pile.
- Quivik: A slurry, yes. In this slurry of finely pulverized ores and water, other chemicals are added to assist in the flotation process. Can you describe what they are and what functions they serve?
- Harris: Sometimes the bulk material, the 98%, it doesn't need any chemicals. It itself is hydrophilic, and stays suspended. If you go by some of the big mills in Arizona, there are huge flat mountains and hills of this unwanted material. The good material ends up in the smelter. It can be filtered off and roasted to get rid of the sulfur. The SO_2 is often taken and converted to SO_3 sulfuric acid.
- Quivik: One of the things that's added to finely pulverized ore and water is oil, of one kind or another. Can you describe what function that serves?
- Harris: I don't remember which oil. Oil is used in the flotation of coal. I never worked on coal until 1989 at UC Berkeley.

Quivik: Didn't they use pine oil in the early flotation process?

Harris: Oh yes, the frother. The collectors are organic compounds containing sulfur, and the better ones sulfur and nitrogen. The benzimate didn't last because of economics, and the Z200 was much better.

Quivik: When you were talking about the process earlier, it could sound like the frothers and the collectors were pieces of equipment. So let's go back, and make it clear that the frother was--.

Harris: You mentioned pine oil. Elmer Tveter, I worked with him. His chemistry was weak, and my metallurgy was weak, so we made a great combination. He said, "Pine oil, all that's good for is disinfecting urinals." [chuckles] He invented Galfroth 250. It's a water-soluble frother. The previous ones were the pine oil, MIBC, and other alcohols. Not the low ones like isopropyl or ethyl alcohol, because they're too water soluble, too hydrophilic. Elmer invented the Galfroth 250, which was a monomethyl ether of a polypropylene glycol. Dow still makes it. The monomethyl ether, a poly-propylene glycol, di, tri, and then four, the still-bottom. There's no market for those. There's no market for the still-bottom.

[Begin Tape 4, Side B]

Quivik: You said there was no market for them?

Harris: For the still-bottom. They developed the use of this still-bottom and if the demand exceeded your still-bottom you could always just push the process toward the higher alcohols. Because any alcohol or propylene oxide--. You can't just make one or two, you get mixture. Dow had a real good frother and a real good collector, and they made good xanthates.

Quivik: What were some of the chemicals that served as collectors?

Harris: Ethyl xanthate, isopropyl, normal propyl, secondary butyl, isobutyl, normal butyl, and amyl xanthate made from a mixture of amyl alcohol. The amyl alcohols were made by the oxyl process, and you get mixtures.

Quivik: Why would a mining company choose one of those collectors over another?

Harris: Because they're lauber, so you get a better recovery.

Quivik: One mining company will treat one type of ore and another mining company will treat another type of ore, so that they'll want to choose the collector that gives them the best recovery for their particular kind of ore. Could you describe how two of those collectors perform differently? Can you give an insight into why one collector would be good for one type of ore and a different collector for a different type of ore.

Harris: In the late fifties, we finally got our first big order of Z200. Anaconda, up in Montana, were using a reagent call Minerek. If you take ethyl chlorocarbonate and react it with a

xanthate, you get a material with the trade name Minerek. It's an oily product. Elmer had done a lot of lab work on Anaconda ore, but they wouldn't listen to him. They decided that they were going to enlarge their mill. In order to do that, they would have had to enlarge their lime plant. They just didn't have the money to do both. Elmer pointed out to them that if they used Z200, they could drastically cut down on their lime requirements, because it works well at a lower pH than that required for flotation using xanthates, or than required for Minerek.

So, they ordered it, and were paying one dollar a pound. Back then, that was big, big bucks. But it did the job. Elmer was back up at Anaconda, and the mill superintendent said, "Hey, we're getting 2% better recovery with the Z200!" Elmer said, "I guess you didn't read my report." [laughter] So they got the report out, and Elmer pointed it out. Well, you might say, what's 2%? When you consider a mill processing 100,000 tons of ore, you can calculate that the increased recovery was a very appreciable amount. You don't have to do anything more in the processing, because you don't have to grind the ore twice. You don't have to use more frother, you don't have to do anything, it's just there. From then on, we had a product. In 1979, when Dow went out of the mining chemical business, they were selling 700,000 pounds of Z200. We estimated that Minerek was selling at least 300,000. This makes one million pounds of the reagent being sold in 1979.

Quivik: They are two different reagents, right?

Harris: Z200 was Isopropyl ethyl thiocarbonate and the competitor's stuff was amyl xanthate, ethyl amyl thiocarbonate. Ours was isopropyl. They cut theirs 50%, MIBC, and Dow would not go for a diluted reagent. The middle management people were not metallurgists, they said, "we're not selling reagents, we're selling chemicals, so we're not doing any diluting!" McGill, in Nevada, when they were operating, our field man pointed out to them that they could dilute the Z200 MIBC and use it as a reagent, and it would make it really cheap. So, the people there called this their reagent, their invention., "Nevada-1."

Quivik: The Anaconda company switched from Minerek to Z200. But your competitor continued to sell a lot of Minerek, 300,000 pounds a year?

Harris: Well, that was the thiocarbonate Minerek not the xanthagen formate. They sold the xanthagen formate in large quantities down in Chile. There is some use for xanthagen formates, but not all that much.

Quivik: So there were two different chemicals that were sold under that same product name?

Harris: Yes, Minerek 27, Minerek 54, et cetera.

Quivik: To get back to an earlier question, for some of those companies, as they tested various reagents in their process, on their ore, your competitor's reagent must have performed better. That chemical worked as a better reagent than Z200? Is that fair?

Harris: Well, the thiocarbonate Minerek got in because when you take a seventy-five cent per pound stuff and dilute it down MIBC twenty cents a pound you get a much cheaper reagent. Dow wouldn't play their game and they knew it.

Quivik: So it was simply a matter of the cost of the reagent?

Harris: There are four thiocarbonate plants in China now, two of them are the Z200 processor. The other two are probably the Minerek processor, thiocarbonate.

Quivik: Did you work at all with reagents that were used in selective flotation, that allowed a company to separate out first zinc, say, and then lead?

Harris: No, they don't do that. One of the things that helped sell Z200 is that it works at a lower pH and it is selective, you get less pyrite, which is deleterious. If you had too much pyrite, your concentrate gets penalized.

Quivik: Were you working strictly in copper-related reagents?

Harris: Copper, zinc, lead, non-ferrous metals, and sulfides.

Quivik: There are some ores that are both zinc and lead-bearing. My understanding of the process is that they run them through a flotation circuit that first produces one and then another. Is that right?

Harris: At the moment I can't remember how that works.

Quivik: But Z200 is only used for copper?

Harris: Copper, nickel, and zinc. It will float lead. One of the thiocarbonates was successful at a mill trial in Canada, I think at Falconbridge. They really liked it. Our middle management guys were all looking for something where they could make a showing, make a splash, to get a promotion. He said, "This was making so much money for Falconbridge." So they raised up the price. We had a frother that I had developed, it was a propylene oxide-type frother. But instead of starting with alcohol, it started with a mercaptan, or H_2S . It was successful in a mill trial at Morenci. Morenci had been quoted a price of fifty-five cents a pound.

At that price, we could make good money, but the middle management guy got greedy. He cranked up the price, and Morenci told the Dow field man, McCarty, where Dow could shove it. So it got lost when Dow went out of the mining chemical business in '79. Instead of initiating the DowFroth with methanol or any other alcohol, Dow goofed. I wasn't in on the patent. ROH, instead of R being alkyl or hydrogen, they just said R is an alkyl. Our competitor, American Cynamid which is now Cytec, used the correct version of the frother and they're selling it today even, and now Dow is letting someone else sell the DowFroth. I don't know the company that's selling the still-bottom, but I'm sure that outfit is making the profits, and Dow is getting the peanuts.

Quivik: Now that we've defined some of these terms and where the chemicals fit into the process, let's get into some of the work that you were doing at Dow when you first got there. You were working on xanthates or on other reagents?

Harris: Xanthates and thiocarbonates. I mentioned that Falconbridge reagent, the Z200 would take xanthate and react it with Dow's methylchloride and then react that xanthate ester with ethyl amin. Isopropylamine is cheaper, but you get a little by-product and the by-

product from ethyl is soluble in the Z200. But if you use isopropylamine, you get diisopropyl thalurea. It's a little like acetylates. It doesn't hurt anything, but if something goes wrong, the superintendent will always blame the reagent. Dow was making ethylene amine, that's a three-member ring, CH_2 , CH_2 , and H. I took the xanthate ester together with ethylene amine and got the product that we wanted without having the methyl mercaptan react with the xeradine, the ethylene amine. Then you get the mercaptan off that you have to handle. That was a good reagent and a neat process, but it got lost in the shuffle at the last minute. One of Dow's big shots was pushing ethylene amine but it didn't just meet up to their greedy standards. The government said ethylene amine was carcinogenic. So what! You only use it as a reactant. But the Texas plant used that as an excuse for shutting the plant down.

Quivik: When you first went to work at Dow, and you were working on new reagents, how did you learn to approach the problems that the research group was trying to address?

Harris: I was the group. I was working with a metallurgist, but I was at an SME meeting and met a new employee at American Cyanamid. He said, "Oh, you must be my counterpart at Dow. You are the manager of the reagent development group." I said, "I am the group."

Quivik: What happened to the people that were working at Great Western?

Harris: Once the xanthate plant got going, one of the fellows, one of the vice presidents, moved back to Midland, he didn't want to be just a chemical engineer, working on problems.

Quivik: But that's what you wanted to do?

Harris: Oh, yes.

Quivik: So you were working with these chemicals that were used by the mining industry in flotation. How did you communicate with the mining industry to understand what problems they needed solved? You could have created any old chemical in your lab.

Harris: I had to be careful. Since I was the only one working there, I couldn't just pull stuff off. If you do that, most of the reagents won't be effective, and you're not getting anywhere. Also, I pretty much stuck to the carbonates, because Dow would not develop a new reagent that would force them to shut down the Z200 plant.

Quivik: Let's go back before the development of Z200. What year did you develop that, '51, or '52?

Harris: Yes.

Quivik: Did you have a small flotation mill at Dow to test things?

Harris: I did, Elmer Tveter would do the testing.

Quivik: Right there in Pittsburg?

Harris: Yes.

Quivik: Did he have a small flotation mill?

Harris: Yes, he had a 500 mL cell.

Quivik: Did he ask mining companies to send him ore samples?

Harris: Yes, they will. They'll send you a drum of their ore.

Quivik: So you would produce a chemical that you thought might perform better, and give it to Elmer. And then he would try it out on a small batch of finely ground ore?

Harris: Yes.

Quivik: Would he give you a sense of how it performed, so that you could have data to take back to your lab and modify your work? What kind of give and take was there between you and Elmer?

Harris: He would comment on how effective it was and whether it needed an extra shot in the arm or whatever. I would think about how I could modify things.

[Begin Tape 5, Side A]

Quivik: You had said that you had wanted to develop reagents that would work well on oxidized sulfide ores?

Harris: Yes, copper ores. So I took a reagent down, and McCarty asked, "What'd you brew this time, Doc?"

Quivik: Who was McCarty again?

Harris: The metallurgist. So, another reagent, and on the third one he gave a thumbs down. I can't be that bad, so I made a reagent that was reported in the literature. It was a good reagent, it wasn't a very good reagent, but it was a good reagent. It failed again, so I realized that it wasn't my reagent, McCarty was doing something wrong. I ordered a lead cell. I was going to finally succumb and do some flotation work myself, but then Dow middle management said, "Nah, we're not going to bother with flotation reagents anymore."

Quivik: What year was that?

Harris: 1979.

Quivik: So that was towards the end. Going back to the early years. What led you in the direction that finally caused you to arrive at what we know we know as Z200? What was the problem you were trying to address? Z200 was a new chemical on the market, and you patented it. The patent was in your name?

Harris: There was a chemist working for me who would steal ideas from me, and he wrote his name on the patent application.

Quivik: Were you two working in the lab together?

Harris: Yes.

Quivik: When you started making Z200, did you know that it would be so effective, or were you just trying various formulations and sending them on to the flotation test mill to see how they would perform?

Harris: It was similar to another successful chemical so I thought it was worth trying.

Quivik: So you cooked up a batch and sent it to Elmer. How often were you sending him sample reagents to test?

Harris: I don't remember, it was some time back.

Quivik: Did you come up with a new chemical each day, or each week?

Harris: No, we had a new research director, a real jerk. This guy was not giving me a raise. A couple of my friends in management went to him, and pointed out to him that I had contributed. This was back in the '70s, and I had contributed about 100 million dollars to the company. I got my raise.

Quivik: And some of your research was dedicated not just to how to develop chemicals, but also the problems of manufacture. Would you like to talk about some of the other forms of work you did?

[Interview 3: July 13, 2001] [Begin Tape 6, Side A]

Quivik: This is Fred Quivik, and we're back at the Bancroft Library for another interview with Guy Harris. After we finished our last interview you reminded me that one thing we didn't talk about was who Dow's competitors were after you started to work for them. Could you describe that for me, please?

Harris: American Cyanamid was our honorable competitor and they sold diathio-phosphates, which is the phosphorous analog of the sulfur compound, the xanthates. They sold diphenylthiocarbonyl diisocyanide and diphenylguanidine. They sold an air froth, which was a polypropylene glycol frother, which gave us competition in our patent department. We practically gave that to them on a silver platter. The other competitor was the Minere Corporation. They were a very secretive outfit, and we didn't have much to do with the Minere people. The president of the company, Dr. Fischer from Germany, he was very secretive. They had a product, made from alcho-chloryl formate and xanthate reactions, without salt. There was also a company making isopropyl chloroformate as an intermediate in preparing an agricultural chemical. They went up to see Dr. Fischer, to try to sell the isopropyl. He said, "Don't know what you're talking about." These people said that they were making isopropyl and why, and Fischer said, "How much?" But said no, they didn't use chloroformate, but what a chance to save some money!

Quivik: When they were competing with you at Dow--. First of all, were they competitors specifically in mining chemicals, or were they competitors across the board for Dow?

Harris: Minere was definitely primarily competing for the flotation collectors. But the American Cyanamid was a chemical company. Minere was a reagent company. They developed--. Fischer died, and the person who took over as president of the company developed a process for the reaction of xanthates directly without amines. There was a paper where they had taken isobutyl xanthate and reacted it with butyl amine, and they got about a 56% yield. That was interesting, but not economically viable. The new president found that if you added a nickel salt to the catalyst, that you got a respectable yield. I don't remember the amount, but it was visible.

So they moved in on us. They were selling their stuff with half isobutyl alcohol, which is a frother. Isobutyl alcohol was about a third of the cost of thionylcarbamate. So when you mixed the two and charged the thionylcarbamate price, you made a good profit. We tried to get the middle management at Dow to do the same thing. They responded, "We're selling chemicals, we don't sell reagents!"

Quivik: What was the difference in their minds? A reagent is a chemical.

Harris: I don't know, we had a lot of incompetent middle management people. I think today Dow tends to just be a commodity producing company. Anything new? Their lower management people can't do the job. Dow had created a material that behaved just like Teflon, but cheaper. They got the patent and the publicity. Dow said that they would license it, which means you take the short end of the stick. When they had the interview, the chemist said he would back in the lab working again on something else.

They had a chance to make big bucks and they blew it. There are other products where they blew it.

Quivik: These competitors, were they in some instances selling identical chemicals to Dow.

Harris: Yes.

Quivik: In other instances, they had a special chemical that they had a patent to?

Harris: Yes. American Cyanamid, their big deal was dithiophosphates. I think I'd made mention that Kennecott, at their McGill operation, now defunct, they were buying the Minerek stuff because it was a little cheaper. We told them that if they take their methyl isobutyl carbanol (MIBC), and add it to Dow's Z200, they could just calculate what their reagent costs would be. "Hey, we can do that?" Our men assured them that they could. So they labeled it "Nevada 1." They went to management, and got nice brownie points with upper management because Nevada 1 was cheaper than the Minerek.

Did I mention that I had been invited to lunch with the American Cyanamid people?

Quivik: When was this, approximately?

Harris: About thirty-five or forty years ago.

Quivik: 1960?

Harris: Yes, maybe '65. Their middle management guys were cut from the same cloth as the Dow middle management people. They said they wouldn't pay for "that Dow bastard's lunch." They said to divide my lunch among the six of them. The middle management jerk was happy, I was happy, they were happy.

Quivik: Let's talk about xanthate. First of all, some general background so that people reading or listening to this interview can know what xanthate is. Can you describe it generally?

Harris: It's a dithiocarbonate ester, half-ester, alkali metal salt. It's made from alcohol, carbisulfide and sodium or potassium hydroxide. It was first made back in the early part of the nineteenth century by a Danish chemist. I had written, for four different issues of the Encyclopedia of Chemical Technology, the xanthate article. One of the reviewers griped that there was too much chemistry in my article!

Quivik: What the was the use that the Danish chemist had for xanthate?

Harris: He was playing around, too.

Quivik: So he just developed this type of chemical?

Harris: Yes, he made it but nothing much was done with it until Keller found that it was useful in the flotation process.

Quivik: What is Keller's first name?

- Harris: Cornelius Keller.
- Quivik: Who did he work for?
- Harris: Minerals Separation of North America, I think. One of the big uses of xanthate chemistry is the cellulose xanthate in making cellophane.
- Quivik: Let's build up to that. So xanthates are a class of chemicals? What distinguishes one xanthate chemical from another xanthate chemical?
- Harris: Well, sodium or potassium salt, and then the alcohol you use determines what the ester is.
- Quivik: Is there a different name for the xanthate depending whether it's made from sodium or phosphate.
- Harris: Well, the dithiophosphates, the analog, they're not a xanthate. They are made from alcohol and P_2S_5 , and the resulting acid, dithiophosphoric acid, a di-ester is reactive with alkali hydroxide or carbonate. That's been one of the standbys for American Cyanamid which is now split and called Cytec.
- Quivik: I'm confused, because I thought you said that xanthate could be either a sodium or a--.
- Harris: Sodium or potassium xanthate. There are sodium or potassium salt in dithiophosphates as well.
- Quivik: Is it indifferent whether sodium or potassium is used?
- Harris: Not flotation wise, but potassium xanthates don't form hydrates, sodium salts do.
- Quivik: Is there a way of giving a name to the xanthates depending on whether they are made from the sodium or potassium salts?
- Harris: Oh yes. X9 was the potassium isopropyl xanthate, and ZII was the sodium.
- Quivik: Do people generally class them as sodium xanthates or potassium xanthates?
- Harris: Yes.
- Quivik: The other difference is the kind of alcohol that is used in making them?
- Harris: Yes.
- Quivik: So that opens up a wide array of xanthates, depending on the alcohol. Are there any other differences? Any other ways that xanthates can differ from each other?
- Harris: Well, methylxanthate is a very poor flotation agent, ethyl is good, and the isopropyl is a little better. Butyl is better. As you increase the molecular weight of the alcohol, or size of the alcohol group, the xanthate, you improve the flotation performance. It goes up and then levels off. When you go from eight to ten, it doesn't make much difference.

Quivik: When did Keller first apply xanthate to flotation?

Harris: 1926 and 1927.

Quivik: Was it a particular xanthate?

Harris: No, it was generic.

Quivik: He didn't care whether it was sodium or potassium.

Harris: No.

Quivik: He didn't care what alcohol was used?

Harris: No. He did squeeze a few extra patents out on the xanthates.

Quivik: At that time, were there any other uses for xanthates besides flotation? Was that the first application for xanthates?

Harris: Yes.

Quivik: Did you say that xanthates were used in making cellophane?

Harris: Cellulose is a polyglucose with a very high molecular weight. Between the linkage connections there are some alcohol groups and you can isolate those groups, or you can make xanthate from that group. When you make cellulose xanthate, it becomes soluble. Then you can do chemical manipulations, and acidify and destroy the xanthates. They're not very stable at acid pH's. You get whatever polymer you're shooting for and cellophane was one of them.

Quivik: When was that development?

Harris: By Dupont, I think in the thirties. I remember that when I got going in the late thirties, it was new.

Quivik: When did people begin recognizing that there were different xanthates and that they would have different performances in metallurgy?

Harris: When Keller started doing his lab work.

Quivik: So he was the one who developed the first several varieties of xanthate. Did he give them different names.

Harris: Great Western was making a xanthate. They had worked out a deal with him, and the price was the license fee. In the old process, they had lump xanthate, and they had some poor guy pounding away, breaking it up. It was "Bear" xanthate. Probably, one of the honchos was a Cal graduate. [laughter] They used to ship it out in 55-gallon drums. I know that I had discussed the process when I was first at Dow with engineers that were developing a new process. They used pentane as a dispersant. The heat of the reaction, sodium hydroxide with alcohol and the alc-oxide reacting with carbonic sulfide, and

with pentane burning at 36 degrees, the heat of reaction went into the pentane. Then the heat was unloaded on the condenser.

They ended up with a powdered product, and they didn't have to make some poor guy's health suffer from sulfide toxicity. They didn't need anyone pounding. It went into a spray dryer, and from the spray dryer it went to a pelletizer. They add a little methanol to facilitate the pelletizing process. The pellets would also pass air through and that oxidized the trithiocarbonate bi-product. When they were first selling the new processed xanthates, they had a problem with stuff catching on fire in the drums. By passing the air through they were able to oxidize whatever it was that was causing the fire. In the drum, when it would react with the air, the heat wasn't dissipated. But when the air was passing through, the heat went out with the air.

Quivik: Was that an impurity that was oxidizing?

Harris: The culprit, yes.

Quivik: The spray dryer yielded a powder?

Harris: Yes.

Quivik: And then they would pelletize the powder?

Harris: Yes, and they would recycle the pentane. Most of the pentane got recycled.

Quivik: At some point somebody started referring to these various xanthates as Z8, Z9, or Z11.

Harris: That was Dow copyright identity. I have a friend at Cytec, and he cringes when I use the Dow terminology.

Quivik: So that was specifically a Dow terminology applied after Dow purchased Great Western?

Harris: Yes.

Quivik: Prior to that, was there any way that Great Western distinguished between its various xanthates?

Harris: They would identify what you're getting by the number. Z3 was potassium ethyl, Z4 was sodium, and Z5 was potassium amyl. Z9 was the potassium isopropyl. Z11 was the sodium isopropyl. Z12 was the isobutyl, and I don't remember if it was the sodium. They made both with the butyl.

Quivik: So Great Western had started to use that "Z" nomenclature beforehand?

Harris: Yes, when we get on to why I was hired by Dow, the benzimate was also called Z105.

Quivik: Where does the Z come from? Xanthate is spelled with an 'x'.

Harris: Maybe somebody's wife was named Zelma, I don't know. [laughter]

Quivik: Okay, it isn't related to anything in the chemical formula?

Harris: No, no.

Quivik: So the purchaser--. It was a lot easier to refer to something as Z4 or Z8, but the purchaser knew which of the xanthates it was and how it would perform on a particular ore in a flotation mill.

Harris: Yes.

Quivik: Okay. Let's jump ahead to where we were talking last time.

I was asking you about the development work you were doing when you came across what came to be called Z200. I was asking you if there was some kind of problem you were trying to solve. Did you think of that as a problem-solving effort?

Harris: No, I was experimenting. I may have mentioned that the more benzimate they sold, the more money they lost.

Quivik: So when you working with xanthates, for example, were you focusing on trying to accomplish a particular thing? Or were you simply trying to see if you could make a new chemical?

Harris: A new chemical that would be a good reagent.

Quivik: Obviously you wanted it to have a good application. But in the first instance, did you try to make the new chemical because you thought it would work better? Or were you simply looking at various chemical compounds that you could make and thinking it would be interesting to make?

Harris: I think I told you that this fellow I had met in San Francisco from American Cyanamid asked if I was his counterpart, the head of the reagent development section. I said, "I am the reagent development section." Since I was working alone, I couldn't afford to just pull things off the shelf. I had to have reasons for believing it might work. If I made a lot of potential reagents that weren't reagents, no one would have any confidence in me.

Quivik: Can you remember why you thought Z200 might work? What was it about that chemical?

Harris: It had the nitrogen and sulfur that could attach to the mineral surface. Well, the chelating agent.

Quivik: You believed that would make it more effective? That would improve its affinity for the bubbles and the froth and its surface attraction. So it would float better?

Harris: Yes.

Quivik: Prior to developing what came to be called Z200, had you developed some other xanthate variants?

- Harris: No, this came pretty early. I had also made analogues of the benzimate, the 105 to see if there was something we could make. I had my hands tied. Dow hates like hell to put money in a new plan on an unproven thing. Also, they didn't want anything that would compete with the Z200. They were all rotten on the Z200 in the beginning because it would compete with their established group of xanthates.
- Quivik: Had there been other "Z's" all the way up to Z199 by then?
- Harris: No, but since they had gone past ten, from one to one hundred was set aside for xanthates. The one hundred series was the benzimate. The thionylcarbamates was another class, the 200's. I had some real good 200 series compounds.
- Quivik: Can you describe the process of coming to recognize that it was going to be a promising reagent?
- Harris: I suspected it would be, so I wasn't surprised when it was. I was kind of surprised that it was so much better than the benzimate. As I mentioned before, the benzimate was an invention of Keller's, and we paid him royalties. Benzimate was a very effective agent, and the sales were going up and up. Someone calculated the economics, and the more we sold, the more money we lost.
- Quivik: How did you learn that it was indeed a good reagent?
- Harris: Whenever I made anything, my buddies in the flotation lab would evaluate it, particularly Elmer Tveter.
- Quivik: How large a quantity did you make in the lab for him to test?
- Harris: Probably one or two hundred grams.
- Quivik: Did you think that this would work on copper sulfides in particular, or sulfides in general? What kinds of instructions did he have? What kind of ore was he supposed to test it on?
- Harris: He had all sorts of ores. He would look at particular ores, particularly at customers who were buying a lot. Pipsqueak copper mines--, he wouldn't spend a lot of time on their ores.
- Quivik: Do you remember what he tested it on?
- Harris: No, he had so many.
- Quivik: Do you remember how he told you that it was working well? Do you remember that exchange?
- Harris: No, Dow management purchased the Z105. They purchased ammonium thiocyanate, and they purchased the alcohol. The diluent was methylene chloride, which was made by Dow. That was the only Dow in the process. They made the Z11, the xanthate, and step number one was to react it with methylchloride. Dow made methylchloride. The

only thing we bought outside was the ethyl amine. So we sold Z200 and methyl mercaptan.

Quivik: Once you learned that Z200 was an effective reagent, what was the next step in turning this into a marketable product?

Harris: Well, we had to sell Dow middle management that they ought to consider another reagent. The economics on the Z105 really killed it. Our first customer was Anaconda.

Quivik: This was for Z200?

Harris: Yes, Anaconda wanted to double the size of their mill. They had the money for that, but they couldn't afford to increase the size of their lime plant. The lime raised the pH. They were using Minerec A which was a reaction product, ethyl chloroformate, and ethyl xanthate. So, they got the diethyl xantholoumate.

Quivik: What year are we talking now?

Harris: Late fifties. Elmer Tveter pointed out to them that if they used the Z200, they could lower the pH. They could double their mill, and they could get by with the old lime plant. It was going for a dollar a pound and the xanthates were going for about thirty cents. The Z200 worked on a lower dosage, so that helped on the reagent price per ton. Elmer went back some weeks later, and the mill superintendent was very excited. He said that he was getting 2% better recovery. That's very important, because increased recovery doesn't add anything to your milling cost. Elmer said, "oh you didn't read my report?" Elmer pulled out the report--.

Quivik: Anaconda was, at that point, actually using Z200 in their concentrator. To get to the point of being able to make Z200 in a quantity sufficient to supply Anaconda, did you have to make changes in the Dow plant?

Harris: We had to build a Z200 plant.

Quivik: Was that a whole new plant or was that an addition on to an existing plant?

Harris: It was a whole new plant right next door to the xanthates.

Quivik: How large a facility was this new plant?

Harris: When we went out of the mining reagent business, we were selling seven million pounds of Z200 per year.

Quivik: But the initial plant?

Harris: That was the same plant.

Quivik: Wow! Was that plant built in anticipation of finding customers, or after Anaconda decided it would buy the stuff?

Harris: That I don't remember. I don't know how they would have made it without the plant.

- Quivik: The facilities necessary for Z200 were not such that there could be a plant set aside for making initial batches of a variety of chemicals?
- Harris: No, we didn't have it. They probably went ahead and--. The Z200 plant wasn't that huge because it was a continuous operation. It wasn't a batch plant.
- Quivik: And it was connected to the xanthate plant, since xanthate was one of the--.
- Harris: That way, they didn't have to drum the xanthate.
- Quivik: As a chemist, were you involved with chemical engineers at Dow in helping to design the Z200 production plant.
- Harris: Oh, yes.
- Quivik: What did you do in that regard?
- Harris: Probably told them what they could get away with and what they couldn't.
- Quivik: Would they come into your lab and try to understand and replicate the process that you had used? Did they try to replicate it on a production scale, or was there something else about it?
- Harris: That was probably the technology flow.
- Quivik: Once the Z200 plant was built and underway, were you at all involved with issues that came up during production? I'm not sure what those issues might be, but troubleshooting or difficulties in the process?
- Harris: The chemical reaction procedure was not a tricky technology, it just worked fine.
- Quivik: So once it got into production, you could turn your attention to other things.
- Harris: [nods]
- Quivik: After Anaconda started buying it--and by the way, what kind of quantities were they buying?
- So, we just did a little estimate on the back of an envelope of what kind of quantity Anaconda might have been buying early on. What did you come up with?
- Harris: One hundred eighty thousand pounds per year.
- Quivik: So once Anaconda started buying Z200, did other mining companies start buying it, too?
- Harris: I know McGill from Nevada was using it. We had customers down in Arizona and foreign customers. The big copper mine in Yugoslavia was using it.

Quivik: Was Z200 only effective on copper sulfide minerals? Or did it have other applications as well?

Harris: It was useful for other metal sulfides.

Quivik: Any worthy of mentioning?

Harris: I can't think of any. I know that there were zinc operations that were using it. Zinc is a pseudo-copper.

Quivik: What was the physical setting for your work?

Harris: My lab bench when I first went to Dow was two-by-twelves on some sawhorses. But then within a year, the new building had opened up and my lab was right by where the service lines came in. I don't think it was the Dow engineer that was doing the design work. But the line taking off from my lab--water was on the underside. That meant that all the crud came along and dropped down. Right in the middle of one of my experiments I needed the water. I had to get going. We in research had our own maintenance crew and I knew that I couldn't wait on them. So I turned it off and broke the union and then put it back together. I saw one of my friends in research maintenance and I told him that I had saved him some work. He said, "Thank God you didn't tell me last week because I was union steward and would have had to report you."

Quivik: How large a room was your lab?

Harris: About 20 percent bigger than this one.

Quivik: And this room is probably fifteen by twenty-five. What did it have in it, lab benches?

Harris: It had lab benches on the side, and a small hood in the corner and a big hood in the center. We didn't have any sawhorses.

Quivik: Did the lab serve as your office or did you have an office elsewhere?

Harris: My desk was off in a corner, and Fischback, who worked with me, was doing something with the vacuum pump. Of course, anything pumped out went into the room. One day, "Oh my god, that's phosgene!" I went over to the first aid and they said, "well, if you wake up tomorrow, you've got it made." [laughter]

Quivik: So he was pumping phosgene right into the room there with you?

Harris: Our safety record really went up when they moved him into management. [laughter]

Quivik: His name was Fischback, what was his first name?

Harris: Bryant.

Quivik: Was he another research chemist? Did he have his own projects?

- Harris: He was working for me at first. He grabbed the Z200 and put his name on the patent. We eventually came together like that.
- Quivik: You just crossed your hands, so you became good friends, had a good relationship? Was that considered your lab?
- Harris: Yes.
- Quivik: Were there other chemists who had labs nearby, on your floor?
- Harris: Oh yes, the building is still there.
- Quivik: How many labs were in that building?
- Harris: About twenty-five or thirty.
- Quivik: And each lab had its own chemist, and that was his or her turf?
- Harris: Yes.
- Quivik: And you typically had one assistant or more?
- Harris: Well, Bryant was my assistant for a while. Then he got to be one of the chemists.
- Quivik: He had his own lab?
- Harris: No, he was in with me. But he was successful, and able to take over.
- Quivik: Take over what?
- Harris: All of the technicians.
- Quivik: Who were the technicians? What did technicians do?
- Harris: They made compounds, and you told them what to do.
- Quivik: So this was a group of support staff. And they were available for you to draw on when you needed assistance?
- Harris: Yes. After Fischback succeeded, I did my own work. Everything that was done, except for filing patents, I pretty much did myself.
- Quivik: You didn't have a technician working with you, then?
- Harris: Not always.
- Quivik: I'm curious about the technicians. Were they people who were on the staff and available for you if you needed them? Or were they permanently assigned to a given chemist?

Harris: Permanently assigned.

Quivik: You mentioned your doctor. Did you mean that your doctor at one time had been one of these technicians and then went to medical school?

Harris: Yes.

Quivik: What kind of people did you work with on a daily basis?

Harris: Technical people.

Quivik: But you were in your lab, you might have an assistant, sometimes you did all of your preparation. Did you go to work and work alone all day, or did you have regular interactions with other people?

Harris: When I completed making a potential reagent, I would take it over to Elmer.

Quivik: And he had his lab across the hall, you said? That's where he did his flotation experiments?

Harris: Yes.

Quivik: Anyone else you worked with regularly?

Harris: Some of the analytical people, particularly Herb Terlinger.

[Begin Tape 7, Side A]

Quivik: You said you would work sometimes with analytical people. The analytical people, what did they do?

Harris: I would take one of our commercial xanthates and pulverize it. I would leave it sit a matter of days, and when the dark color would disappear, I would know the impurities had been oxidized. I would take that in and they'd run an assay on it using a silver electrode.

Quivik: So they had facilities to do that kind of assay work and other analytical work for everybody?

Harris: Yes.

Quivik: From this interview, I've gathered that one of your favorite classes of people were middle management. How often did you get to meet with them?

Harris: I'd say hello to them in the hall.

Quivik: Did you have to make reports on what you were doing?

Harris: Oh, yes, we used to have write monthly reports.

Quivik: Did they go to these middle managers?

Harris: Yes, anyone who wanted to look at them.

Quivik: What kinds of things did you describe in those reports?

Harris: The things I had made, or planned to make.

Quivik: Did you include some sort of evaluation of what you had made? How was your work evaluated? You said earlier that you needed to be finding reagents that actually worked well. How was your work as a chemist evaluated, to see if what you were doing had practical applications?

Harris: The person I had to report to, I also talked with them. I talked to the immediate boss, who I got along fine with. Eventually I got a promotion and I didn't have a boss, just someone I reported to on paper.

Quivik: Who was your boss, when you had a boss?

Harris: Luke Simonson, a chemical engineer from the University of Washington. We all worked pretty closely together. He moved into production, and I was working for a chemist named Ted Norton. That was a good relationship. I worked on a lot of other things besides reagents, but at the beginning the reagents were one of my primary efforts.

Quivik: Did these guys like Simonson and Norton have their own research labs? Or did they just supervise a group of research chemists?

Harris: Simonson was definitely just supervisory, and Ted Norton was both. Ted moved back to Michigan, and was in charge of a big research lab there. He just quit Dow, and they didn't want him to go. He was very good and honorable, a unique manager.

Quivik: Did they sometimes have research assignments for you?

Harris: If something needed to be done, I would do it. I wasn't that obnoxious.

Quivik: Would you say that in those early years most of your work came from assignments that were give to you by your supervisor? Or was most of your work self-directed? Which was it?

Harris: My own.

Quivik: When you were doing this reagent work with Elmer, he actually did the flotation tests. But before you started working on that, how much did you know about extractive metallurgy?

Harris: Nothing, when the flotation lab moved from San Francisco to Pittsburg, I went in there and they had all this funny stuff, and they were scraping off foam. I thought, "what on earth is going on here?" I hadn't the foggiest idea. When I was in junior college, I was interested in minerals. I worked in the lab, and I set up as if I was doing class work.

That cost me an A. He said I did "A" work but it took an awful lot of time. I couldn't tell him that I was using their equipment and chemicals so that I could play around with my mineral study. That's the closest thing. I got the mining merit badge. I had friends who were interested in locating minerals. That was in my youth. I had not taken any classes. It was just kind of osmosis.

Quivik: From spending time with Elmer?

Harris: Yes.

Quivik: During that time, did you ever visit any metallurgical plants, to see how--?

Harris: Oh yes, I had gone out with Carl Williams on one of his tours. I remember we stopped at Winemucca and he ordered a steak. He wanted it rare, he said, "knock off the horns and bring it in." Our primary goal was a visit to McGill. We visited some other small mines, and we were heading back towards Reno to cross over to California. He slammed on the breaks and said, "It's a stamp mill when it's working." That was the only stamp mill I'd seen. It was interesting. But McGill was a big operation. I went out on other times after that.

Quivik: During this reagent phase of your work, did you ever have any direct communications with people in the mining industry?

Harris: Only the few times I went out with the field man. Then I would meet them at the SME meetings. That was the only relationship I had. Generally, Elmer handled that, and I handled reagent development.

Quivik: If Elmer wanted someone to try a chemical, or if they had a question about reagents, they would come into Elmer? You wouldn't field those types of questions from potential clients?

Harris: No. I met development people at Climax. We visited their research lab in Denver.

Quivik: What kind of research did they do? How did they compare?

Harris: They were more Elmer Tveter research.

Quivik: So they would be testing reagents on their ores?

Harris: Yes, working on their process.

Quivik: At some point you got a promotion. You had someone that you reported to, but it was no longer your boss. Did that change your daily routine at all?

Harris: No, I did what I wanted to. I was considered an obnoxious bullhead. I was told the reason I didn't get the top rating is that the people back in Midland didn't like my negative attitude towards management.

Quivik: We should talk a little bit about the Dow hierarchy. When you say, "people back in Midland," what is that?

- Harris: Well, the honchos. I had friends back in Midland. One of my friends became very unpopular with the middle management research people. I remember going into the country club for lunch in Midland with the obnoxious--I like him, but the unpopular guy. I said hello, and they just kind of glared at me. Eventually I realized that it was because of who I came in with. That didn't help me, to associate on a friendly basis with Joe Dunbar.
- Quivik: What was his position?
- Harris: Something like mine, doing research. Dunbar, eventually they told him to find a job in or out of Dow, but nobody would hire him because his bosses would badmouth him. One of the honchos was out at our house for dinner and he mentioned Joe Dunbar. He asked if he should hire him, and I said, "You know and I know how Dunbar can be kind of obnoxious, which is an understatement. [chuckles] But you know and I know that he is a damn good chemist. You know, you're a bigger man than that." He said, "I'll hire him." Joe came that close to being dumped out on the street.
- Quivik: He was a research chemist at Midland. How about Pittsburg? What was the hierarchy within Dow? Did your supervisor report to someone at the top in Pittsburg?
- Harris: We had a research director. When I got to Dow, we had a research director, Dr. Wilhelm Hirschkind. He got his Ph.D. under Haber, the man who developed the ammonia process. Eventually he had to retire, and Robert Heitz took over. When I got my promotion I reported only to him.
- Quivik: Hirschkind and Heitz were both at Pittsburg?
- Harris: Yes.
- Quivik: Did they report to some research vice-president at Midland.
- Harris: Yes, the company research director back in Midland.
- Quivik: How often did you go to Midland?
- Harris: Oh, fairly often. It was an all-day ride just to get to Chicago in a DC-6 or a DC-7. Then we'd take a secondary airline flight to Midland.
- Quivik: How long was that flight?
- Harris: An hour or two.
- Quivik: What was the purpose of your trips to Midland?
- Harris: Sometimes I gave technical talks. Generally, I would interact with the people in the labs back there.
- Quivik: Exchange techniques?
- Harris: Techniques and ideas.

Quivik: Did Dow put any sorts of limits or parameters on your research?

Harris: No, they left me alone.

Quivik: Why is that?

Harris: Because I was obnoxious.

Quivik: But from the Dow perspective? Is that the way they treated all of their research chemists?

Harris: No, I was good, if I may take my bows now. So they felt--. I remember one time they assigned someone to me, and he wanted to go back and get a master's at Berkeley. They told him that he could work for me for a year, and he would get the ranking in pay as if he had a master's. We had a consultant from Berkeley, Melvin Calvin, who eventually got a Nobel prize. He lost three bets with me, and he would have lost a fourth but I couldn't remember which book to bring out to nail him. He was arguing that Fischback was--. At first I signed up to interview with him, but I figured it was a waste of time. Fischback was doing a political thing, and was signed up for Calvin. They were arguing away, and I got fed with the argument and said, "Fischback is right." Calvin said, "Well, if Harris says I'm wrong, I'm wrong."

Quivik: What kinds of things did Dow recognize in you that made you good? What makes a good research chemist?

Harris: Well, back in the seventies, we had a new research director who wouldn't give me a raise. He didn't like my untidy lab. Fischback and another fellow went in to see him and laid it out on the research director's table. "This guy has contributed to over one hundred million dollars in profits to the company." The guy said, "Oh, I didn't know that." [in mocking tone] So I got my raise.

Quivik: So to say that you were good depended on your track record of making good products for Dow. Do you know how your track record compared to other chemists?

Harris: I never paid attention to that. One of the products they made big bucks on was a product to add to chicken food to control coccidiosis. With that disease, if you walk into an infected chicken yard and then walk into your own chicken yard, you would lose your chickens, too. So these commercial people could lose thousands of chickens in an outbreak, so this was very important stuff.

To give you an idea of the value of it, Merck was our competitor. They knew our stuff was really good, and they had something that was pretty good. So they wanted to hold us up, because their stuff was going to be online. So they bribed the fellow Food and Drug Administration. We had done our lab work, and we didn't have the animals anymore. We had sacrificed them to study their internal--the way things were. This guy said that we had to do a year's lab work, not just six months. They changed the ground rules. That meant that we were held up for another year. That guy wound up working for Merck, and after a few years was able to retire. It was pure bribery. But with such a super-lucrative drug, it was whatever you had that works. Somebody at Merck said it pays to bribe. What's new?

Quivik: Let's have a little background on that development. First of all, what does coccidiosis do to chickens?

Harris: They don't last long, they die, they drop dead.

Quivik: They get some kind of illness?

Harris: Yes, in their innards. If you don't have your birds in pens, or if you change your shoes, if it gets in some chicken feed, it's highly contagious.

Quivik: Do they contract the disease from what they eat, then, or by walking in it?

Harris: All sorts of ways, any contact you can think of.

Quivik: Even airborne?

Harris: Possibly.

Quivik: How did you get involved in that line of work?

Harris: Fischback was cranking out compounds and sending them in.

Quivik: To whom?

Harris: Our test lab back in Midland. I told him, "Make the amid." I just knew the acid wasn't worth much.

Quivik: What kinds of compounds was he cranking out?

Harris: Di-nitro-benzamid; 3-5 di-nitro-benzamid.

Quivik: He was just making a lot of that chemical?

Harris: He was just making it for the agricultural lab. The animal test was also part of this lab. When we make anything, we automatically make enough to send ten grams to the ag. lab.

Quivik: The agricultural lab at Midland. So Dow Chemical's research lab at Midland was working on this coccidiosis problem, and asked Fischback to--?

Harris: No, he was making the compound. We ended up making the 3-5-di-nitro-toluamid, and that was the best. In my list of patents, you'll see some of this stuff. I developed the process. If they were still making it anywhere, it's not Dow. When the patent expired, Dow had to stop because they can't compete with this cutthroat business.

[Begin Tape 7, Side B]

Quivik: Is that an instance where a research assignment came from headquarters?

- Harris: No, when they developed an interest in it, I got working on the process for making an intermediate. In my process, we could take 85% pure orthotoluic acid and get 99% quality out of the process. It just worked like a charm.
- Quivik: What was the compound that Dow made that solved this problem?
- Harris: [It was] 3-5-di-nitro-orthotoluamid.
- Quivik: That was a chicken feed additive. How did that address the coccidiosis problem?
- Harris: You just added the stuff to the chicken feed and collect your eggs, and sell your chickens off to the slaughter. It kept them alive.
- Quivik: Did it help them develop a resistance to the disease? Did it cure them after they got the disease?
- Harris: It's preventative. There was no cure, because as soon as they got sick, they were dead in short order.
- Quivik: Did it work as a--?
- Harris: --Preventative, I don't know what the medical term is. Prophylaxis.
- Quivik: So they knew already that the chemical was effective? Your contribution was to figure out how to make it?
- Harris: Yes. I made sure Fischback sent the amid in.
- Quivik: What was the significance of that?
- Harris: It is not particularly water-soluble. The acid would go through the chicken in a rush. If you swallowed some, the body would quickly eliminate it.
- Quivik: And the amid would be retanized?
- Harris: It was slowly metabolized.
- Quivik: You knew that Dow was working on this problem. Was it in the company literature?
- Harris: No, when we would send stuff in, we would get reports. Most of the things we made weren't all that active. When something was really good for an herbicide, we'd get the test results. If we had something that looked interesting, then we'd start making analogs to try to come up with something better.
- Quivik: So you knew that this was work that was going on in the company. You just thought that this looked like fun stuff to work on? How did you happen to get into it?
- Harris: I knew that acid had a little activity, and I told Fischback to make the amid, because it would be more effective. That made millions for the company. If the organism hasn't

developed resistance, and they're still making it, they're using my process. Because you can't beat it.

Quivik: What's the connection between your process and your telling Fischback to send in the amid?

Harris: The process came later.

Quivik: I see. The amid proved to be the effective chemical, and later on you started working on the process for making the material. What year was that, roughly?

Harris: Probably in sixties. Look at the patent.

Quivik: You looked at your list of patents, when were you working on the chicken feed additive?

Harris: Late fifties.

Quivik: Were there other agricultural chemicals that you worked on?

Harris: Yes, but they don't come to mind. They're in the list of patents.

Quivik: You worked on something related to rocket fuel at one point?

Harris: There was a pushy gal, and I always liked her. She had a rocket fuel as a solid. She had a secret contract, and I didn't have a Q clearance.

Quivik: What is a Q clearance?

Harris: That I could have access to confidential material. It's a security clearance by the government.

Quivik: Do you remember her name?

Harris: Phyllis Derner O.J. Jones. Derner when she first came, and then she married and re-married. They were making it out in the pilot plant. We'd go by on the way to the cafeteria, and it smelled pretty fishy. Tri-methyl, methylene, or tri-methylene, it was one of the three, and she borrowed some isopropyl chloride from me and said it wouldn't work. So I knew it was a nucleophilic displacement reaction of some sort.

My friend in analytical said there couldn't be any bromide in her product. Bromide is a much more reactive agent for these displacement reactions. Isopropyl bromide, probably reacting with the trimethylene. The fellow doing the analysis wasn't cleared either. But he knew what the figures were, and that wasn't classified. From the nitrogen, and knowing rocket fuel wanted nitrate: trimethyl isopropyl ammonium nitrate. I took a practically empty reagent bottle from stuff we had bought. The typing was kind of faint, so I erased it and smoothed it down with a glass rod. I steamed off the label and the research director's secretary type isopropyl triomethyl ammonium nitrate on the bottle and put it back on. We had the fellow from the store room come in with this bottle and we were all around Fred's desk. Just happened to be there!

Quivik: Who is Fred?

Harris: He had the other half of the lab that Phyllis had. George said, "Fred, you got any of this?" Fred knew what he was supposed to say. No, he didn't have any and Phyllis said maybe she'd have some. When she saw what was typed on the bottle, she went roaring up to her boss, called the FBI: "There's been a security breach." Her boss calmed her down. Our boss called one fellow, who was quite involved in hallucinogenic drugs. Sascha was called in and got blamed for it.

Quivik: Who was Sascha?

Harris: The hallucinogenic drug scientist.

Our boss never closed his door, but this time it was closed, so he knew who it was. Sascha came out, and told us that all the boss had said was to knock it off.

Harris: I developed a process for making the rocket fuel starting with the bromide. Not having to use the iron exchange resin made it a much simpler process. We filed a patent on it. The patent attorney called me in to sign the application, he covered it, and he said sign here. I said, this isn't a grant deed to my house, is it?

Quivik: He covered up most of the document? You couldn't see what you were signing?

Harris: Yes, I wasn't cleared. I didn't have security clearance.

Quivik: So you were still working on this process, even though you didn't have clearance. Were you working jointly with Phyllis?

Harris: Oh, no, I was working on my own. Eventually the deal was declassified, and then they issued my patent.

Quivik: Did Phyllis use your process?

Harris: That I don't know. I just know that it got filed.

Quivik: And it was related to the work you were able to decipher that she was working on.

Harris: Yes, we all had to be there.

Quivik: Do you know if it had any practical use?

Harris: They were using it, because we were making large amounts in our pilot plant.

Quivik: But you couldn't learn any more about it because you didn't have clearance. How about other chemicals that you developed related to the mineral industry?

Harris: The Z211 was an analogue of Z200. If you take Z200, and the ethyl amin and add on sulfide methyl, that's 211. It was very good in Canada. I forgot the name of the mine, a big nickel mine in Canada.

Quivik: Near Sudbury?

Harris: Yes, they really liked it, because it really enhanced their recovery. But the middle management guy said it was saving it them so much money that they raised the price. The Canadians told us what we could do with it.

Quivik: So was that was being used for nickel?

Harris: It got patented, but middle management guys ruined it, as they did on our frothers.

Quivik: But what was the application, on nickel?

Harris: Yes, it was used for nickel flotation.

Quivik: I also understand that you worked on uranium processing somehow?

Harris: Well, in the uranium process, they take P_2O_5 and alcohol, and you get equal amounts of the di-ester and the mono-ester. Mono-ester is no good for uranium flotation. There was no way to eliminate getting the mono, because P_2O_5 and alcohol produces water. That equivalent gives you the mono-ester. So I thought, if you take glycol and form the epoxy, you eliminated water. So I have a couple patents on the reaction of P_2O_5 with C10, alcolene oxide. We tested for everything except uranium. I don't know why, but I'd be willing to give you long odds that it was a uranium collector.

Quivik: Who figured out that it was a uranium collector?

Harris: I don't know why the lab people---. I don't remember.

Quivik: Was it used for--?

Harris: No, but that was the reason I made the material, to be used as a--maybe it's mentioned in the patent. I don't know.

Quivik: You developed it to be used as a uranium collector, but they never tested it?

Harris: No.

Quivik: So that was a dead end development, it never went anywhere?

Harris: Right.

Quivik: It's just sitting in the patent office and that's it?

Harris: So much did not get done at Dow.

Quivik: Let's turn our attention to some of the folks you worked with. Let's get some reminiscences. First of all, did you ever know Keller yourself?

Harris: Oh, yes, he's buried over in Holy Cross Cemetery in Colma. He had a keen sense of humor, I can still see his eyes twinkling. He was telling some of the stories, when he

was down in Mexico. He was a prisoner of Pancho Villa. Villa had these cannons, but he ran out of gunpowder. The Mexican and American governments made it difficult for him to get a hold of any, so he wanted to use dynamite. Keller was smart enough to know that the first time he got something dynamite-based, after the first shot there would be one less cannon, and one less Keller.

Keller was from Switzerland, he could speak, read, and write French, German, Italian, Latin, English, and Spanish. He told us one time that he had a boss snooping in his notebook. So he started to write his notebook in Latin. [laughter] Which is perfectly legitimate.

Quivik: How did you get to know him?

Harris: Because he use to come out, see how things were going. He also talked with the flotation people across the hall, because he had worked with them in San Francisco.

Quivik: So he would come out to the Pittsburg plant.

Harris: Yes.

Quivik: How about John Locken?

Harris: Oh, that guy. He was in charge of the lab--. He could tell daylight from nighttime. I remember one time Elmer got a patent for something, and Locken said he wanted his name on that. He wasn't an inventor!

Quivik: What was his job?

Harris: He was the head of flotation. Elmer worked for him. At first he told Elmer, "You spend too much time talking with Harris. I want you to stop." But Elmer didn't pay any attention to him.

Quivik: Was Locken a metallurgist?

Harris: Of sorts, yes.

Quivik: He came out with the San Francisco lab?

Harris: Yes.

Quivik: Did you work with him directly?

Harris: No, I worked with Elmer.

Quivik: How about Darryl Anderson?

Harris: Darryl Anderson came out in charge of the lab, we were good friends.

Quivik: The flotation lab?

- Harris: Yes.
- Quivik: So what was the difference between Anderson and Locken? I thought you said that Locken was in charge of the flotation lab.
- Harris: At first. Then later on, Locken stopped being in charge and Elmer was. Elmer is a lot like me, and if something had to be said, he said it. They had a big layoff in the late fifties, and they fired Elmer. Hirshkind heard about it, and the same day he was re-hired and came out to Western and we worked together. He was not in the flotation lab, because the guys that fired him really had higher authority over the flotation lab, and they fired Elmer.
- Quivik: And Hirshkind rehired him to do what?
- Harris: What he always did, reagent development.
- Quivik: But in a different area.
- Harris: He was back in Midland when he got fired, and then he came back.
- Quivik: Oh, I see, so he came back to work in Pittsburgh?
- Harris: Back to Walnut Creek. We had a Walnut Creek lab, too.
- Quivik: That was another Dow lab. So Darryl Anderson succeeded Locken as head of the--.
- Harris: No, when they dumped Elmer, they hired a metallurgist. The name escapes me right now, but that fellow quit Dow. He was outspoken, but he was good.
- Quivik: I'm confused, when you say that he "took Elmer's place" do you mean when he went to Midland?
- Harris: Elmer moved to Midland when they moved the lab back to Midland.
- Quivik: They moved the flotation lab to Midland, and Elmer went with it. Did Locken go with it?
- Harris: He had retired by then.
- Quivik: And was Darryl Anderson part of that move?
- Harris: He came later. They moved their lab back to Midland. Elmer didn't like their ineptitude and let them know that they were pretty inept, so they decided to show him who was boss, and Elmer got the can tied to him. Elmer moved back to Walnut Creek, so it had to be after '62. After Elmer came back, they moved the lab to Walnut Creek.
- Quivik: Did they continue the flotation lab in Midland?

Harris: They transferred it back out here. The man whose name I don't recall, when he quit they sent Anderson out. He ran the lab, and he listened to people. He was replaced by a fellow from Texas, a civil engineer.

Quivik: How did that affect your work?

[Begin Tape 8, Side A]

Quivik: So it must not have been nearly as convenient, when Elmer was no longer just across the hall.

Harris: No, it wasn't.

Quivik: When both he and the flotation lab moved back out here, did you continue working with him then?

Harris: Oh yes, but he was part of our research group, not the flotation lab. He'd been fired!

Quivik: Was he still working on flotation, though?

Harris: [laughter] Yes.

Quivik: Just under a different group?

Harris: Right. When that chemical engineer came, it was almost impossible to get anything done. There was a very prominent--he lied and cheated to get where he did. But he got to the top, president of the SME. Fuerstenau knows him, too. That guy, he killed the mining business for Dow. He had a material called 5F, grinding aids. Grinding aids cost the company a lot of money, but they never made a dime off of them. They airmailed a plant down into Chile to make this stuff, but nobody ever used it. Last I heard, there were a thousand drums of it, sitting in a warehouse in South Africa.

But Klimpel, when asked about the profits, he gave a large figure. The Texan was amazed. Klimpel kept raising the ceiling on the profitability of it. They were pouring most of the money they were making off of mining chemicals into this grinding aid project. They weren't making anything off of it. Unless you were being snowed by Klimpel, you figured it was a loser. So the middle management realized that all the mining chemical business does is build up a big, fat budget for research, so they called it quits.

Quivik: Who was Klimpel?

Harris: He got a top science rating, because he knew how to snow people.

Quivik: Who was he? Did he work for Dow?

Harris: Yes.

Quivik: Was he a research chemist like you?

Harris: No, he was a promoter.

Quivik: What part of the business did he work in?

Harris: Hmm.

Quivik: What was his first name?

Harris: Dick Klimpel.

Quivik: Was he a manager?

Harris: Yes, he managed something. Then he conned Dow into forming a joint chemical reagent business. The reagents that he patented were worthless. One of them is being sold by Scitech because they bought the patents. Dow and the steel company were joint on this company. Dow said, if in five years they weren't making big bucks--. Klimple said, oh, there's going to be millions and millions. If you said "wow," he'd know that he had you on the hook, and he would elaborate even more.

Quivik: Did he work in the Pittsburg office?

Harris: No, he was back in Midland. Dow had a policy that you don't stay in a managerial spot for more than five years, they keep moving. By the time a new guy had come along, he would snow him. By the time the guy realized what a jerk he was, there would be a new manager.

Quivik: You've talked about Hirshkind, anything else you want to say about him? He was in charge of the overall lab in Pittsburg?

Harris: When Dow bought Great Western, they kept him on as research director.

Quivik: Was he a chemist, a metallurgist?

Harris: Well, he got his Ph.D. under Haber, the inventor of the ammonia process.

Quivik: Where was it that he did his Ph.D.?

Harris: Germany.

Quivik: Do you know what university?

Harris: The one where Haber was.

Quivik: Bob Olson?

Harris: Berkeley graduate. We worked together on this project, cockolene oxide. He was doing something with uranium. He worked on anything engineering related, and he was interested in flotation.

Quivik: Was he a research chemist?

- Harris: Yes.
- Quivik: Did he have his own lab?
- Harris: Yes.
- Quivik: So you and he were peers?
- Harris: Yes, and the two years I was teaching in Ghana, he got a letter from the San Francisco Opera about tickets. But the letter was addressed to Guy Harris at his address. That way I kept my good seats.
- Quivik: So you were a long time season ticket holder at the San Francisco Opera?
- Harris: Yes, some years back I got a certificate for going thirty-five years.
- Quivik: Did Bob Olson start work there after you did?
- Harris: He came later.
- Quivik: And Carl Williams?
- Harris: He came with the San Francisco lab.
- Quivik: What kind of work did he do?
- Harris: He was a field man, but he would do lab work on customers' ores.
- Quivik: So he worked closely with Elmer. [Harris nods] Then he went out into the field visiting mining companies? [Harris nods] More than Elmer did? Or comparable?
- Harris: You might say comparable. He got over to India. I met an Indian at the SME meeting, and he asked about Carl.
- Quivik: Did you work on projects with Carl?
- Harris: Primarily Elmer.
- Quivik: Was he in the same flotation lab?
- Harris: Yes, John Locken was in charge. It was him, Elmer, Carl Williams, and Clarence Zeuch.
- Quivik: Did they all go off to Midland when they moved the lab there?
- Harris: Yes.
- Quivik: And did they all move back to Walnut Creek?
- Harris: Yes.

- Quivik: Clarence Zeuch, he was the other metallurgist.
- Harris: Yes, they gave him an early retirement package. He went to work for Minerek.
- Quivik: The competitor. When someone did that, did they have to sign a non-disclosure agreement?
- Harris: Whenever you go from one company to another, you have to sign something saying that the ideas belong to the former company. Everywhere I worked, I had to sign one of those.
- Quivik: You mean each time you switched jobs, earlier in your career?
- Harris: Yes.
- Quivik: You've mentioned Melvin Calvin, anything more you'd like to say about him?
- Harris: Hirshkind gave up being research director, but he still had an office and came in. When Calvin got the Nobel Laureate, Hirshkind put a little party on for Calvin in the company cafeteria. One of the fellows said, "sure you come." Hirshkind came up to me to say it was just a little party for Calvin, and I was so mad I could have spit. I picked up my plate, and walked over to a table. Calvin came over and said, "come on back." I said no, the doc told me he didn't want me. He said, "I want you." That was Calvin. Hirshkind came up later and apologized.
- Quivik: Let's turn our attention to your two years of teaching in Ghana. That was from 1962 to 1964. Can you describe how you came to do that in the first place?
- Harris: One of our chemists quit and was teaching over there.
- Quivik: Teaching where?
- Harris: At the University of Ghana. He wrote to me to try to get some of the fellows to come and teach. The professor who was the head of the department was English. The professor was let go, and a Ghanaian became department head. So the English guys just left, they didn't want to work for Torto.
- Quivik: He was the Ghanaian professor?
- Harris: Yes, Frank Torto. They needed people. So I asked all the liberals and they all said, "oh yes, I'd love to. It's a very important thing to do, but I just can't make it at this time." So the only person who went was this old conservative. All the fuzzy liberals had excuses for doing nothing. I went, and I got notice in early July. All the other notices they had sent out, the people had taken other jobs. If I didn't get hired, it didn't matter to me because I already had my job at Dow. These other guys didn't have anywhere else to go.
- Quivik: Where did you get the notice from?
- Harris: I got a telegram from the University of Ghana.

Quivik: Saying that you had been hired at the end of July, 1962?

Harris: Yes. So we leased our house to a lieutenant colonel in the army, flew to England and then to Ghana.

Quivik: Was it difficult to get a leave of absence from Dow to do that?

Harris: Well, I saw Heitz, my boss, and said I'm leaving. I didn't ask for one, but I got one. They didn't want to lose me.

Quivik: Did you know at the outset how long you planned to spend in Ghana?

Harris: They gave me a leave of absence for up to two years. I thought I was going for one year, but they wanted me to stay. My family came back after the first year.

Quivik: They stayed one year, and you stayed two years.

Harris: Yes. I went with the family up to Europe after the first year. I gave a paper in London at the IUPAC meeting. Then I picked up the Mercedes and joined my family in Cologne. My wife was visiting a cousin of hers. I dropped them off at the Frankfurt airport, drove down to Stuttgart and dropped off my car. They took me to the motel. The next morning I got on the plane for Ghana. You ever left your wife for nine months?

Quivik: Not nine months, no. Seven weeks is the longest.

Harris: It seemed like a long time, nine months. I came back and I had wanted to go to Timbuktu. I ended up going to the north of Nigeria. I spend a couple days in Kano and caught the plane for Germany. I stopped in Cologne to see my wife's cousin who was in the hospital with cancer. I saw him before he had to check out with the cancer.

Quivik: What kind of a university is the University of Ghana?

Harris: One of my friends asked what it was like, if it was like our high schools. I said that for chemistry we had two levels. The general degree, for which you had to have the equivalent of two A.B.s, and the special degree, which was like a B.S. We used a very popular textbook of the time for the general, and for the special degree we used the Pfizer and Pfizer. He said that was his textbook in college.

Quivik: Was this the only university in the whole country?

Harris: They had a technical university up in Kumasi. The Kwame Nkrumah Institute of Science and Technology. We always referred to it as Sagafo Tech. That was the name he gave himself, which means redeemer.

Quivik: Was it a full university with all the academic departments that you would expect?

Harris: Yes, we didn't offer Ph.D.'s, then. I gave them homework. Some didn't bother, some did. Everything was based, as the English system, on the big June exams. I was told in late September or early October to write up the exams for the work. I got corrected on

it, so I rewrote it, closer to what they wanted. Then they sent it to University of London, and they had to approve it. We had a special relationship with London University to make sure that our classes were equivalent.

Periodically, I would go up to the registrar's office, and they would go into the vault and bring out my test. I was not to write down anything. We would go to make sure that we were covering all the material in that big exam. It wouldn't be fair to the students to give them a question that they hadn't been instructed in. At the last, if you were covering something kind of out of line, the smart students knew it would be on the final.

Quivik: Did all the students have pretty good English?

Harris: English is the official language. The special degree class only had two students. One of them, the guy was real smart, but lazy. I kept telling him that he had to go to Berkeley. He was going to go to the University of London. But in the English system, I knew that he would just do lab work and never have to work the mind. So I saw George Penetel and laid down the line.

I said he was lazy and smart. He said he thought that they could straighten him out, tell him to apply here. Tell him not to use you, and that way he'll get four references. He came here and got his Ph.D. After the first semester, I said, "Tong, sign up for the senior organic class, you'll have no problem."

At that time, Berkeley required you to take a set of placement exams. In countries like India you get a nice grade if your uncle is a big honcho. Berkeley knows that, and Indian transcripts--we don't pay any attention to them here. So I said, sign for the senior organic. I said to take the 206. But they told him, because of the test, he couldn't take it, he'd already had it.

Quivik: In other words, he had all that preparation already from the university in Ghana.

Harris: Yes, as far as organic was concerned, he had completed his first year graduate.

Quivik: The students that you taught in Ghana, did they come from public high schools, or private schools, rural areas, urban areas?

Harris: I don't know. But they were all in their late 20s. When the family had the money, the oldest boy would go to school. When they didn't have the money, he wouldn't be going to school. Apparently, secondary school can be off and on.

Quivik: How were the facilities at the university then? Did they have good lab facilities and classroom facilities and so on?

Harris: Good classroom facilities, the lab equipment--

[Begin Tape 8, Side B]

Quivik: OK, the classroom facilities?

- Harris: They were a little better than the other regional university I went to. A year later, Dow paid my way back to a West African Science Association meeting in Sierra Leone. I went and visited a lecturer from the university in Nigeria. I met a fellow from the University of Michigan, he had taken a leave of absence for a year and was teaching over there. He said his bright students had nothing to work with. He gave them exams, not British-style but Michigan-style, and he said that if they were at Michigan they would pass with honors. He said an old simple UV spectrophotometer is the only equipment they had. We were slightly better than that.
- Quivik: Where did you and your family live while you were there?
- Harris: We had a nice hut. Hardwood floors, bath and a half, electric stove, daily garbage collection, and it was right next to the vice-chancellor's place. It was a nice "hut."
- Quivik: How about food and cooking, and that sort of thing?
- Harris: Well, an electric stove and a servant. He did the cooking.
- Quivik: African food or American food?
- Harris: English! A little American; my daughter Mary made sure that he did it right.
- Quivik: Did you learn to eat some Ghanaian foods that you liked?
- Harris: Oh yes, in cold weather we have Ghanaian stew. I cook it. We don't have crab, but we use canned tuna.
- Quivik: What's in Ghanaian stew?
- Harris: Well, it has okra, tomatoes, and a certain amount of peppers, chili. They love the hot stuff. Well, most of them do.
- Quivik: Those are the main ingredients. That sounds like it isn't terribly unusual. Did you encounter any really unusual foods there?
- Harris: One place made doughnuts. They cooked it in coconut oil. At first it was weird, but when we came back there were no places to get doughnuts cooked in coconut oil. You kind of get acclimated.
- Quivik: What other sorts of unusual experiences did you have in Ghana?
- Harris: We had a friend, she's still alive, she's 98. She's from Cincinnati, and she stopped by to see us. We borrowed our friend's car, and went up to Kamas. The next day, we went up to the dam. The Volta river dam was supervised by Kaiser Engineering. The contractor was an Italian outfit. So the road signs were in English and Italian. We were taking our friend to the dam, and we had to stop at this roadblock. Someone had lobbed a grenade into the car of the dictator, so they had flown in specialist doctors from London. They worked on him about eighteen hours, getting fragments out. He sealed off the city of Accra. There was no way you could seal it off. If I had wanted to, I could have just walked off to the side.

Normally, they would stop us at this road block and ask if we had any bombs, and we would say no. But this time, the police commissioner was there, with his little stick, British style. The only difference between then and when it was a British colony was that the police commissioner's skin was white.

They had to check, and our friend was not about to be searched. She got arguing, and the police commissioner said, "You're a Ghana man, can you do something to that woman?" I said, "No, I knew her husband when he was alive, and he couldn't do anything with that woman." Finally, she let them look in her purse. I can still see that old black policewoman, holding her hand, they were afraid of that vicious white woman.

We went out to the dam, where there was a hotel. You could get something to eat or drink, and it overlooked the construction of the dam. The dam was a concrete wall, and then the earth fill would keep the wall erect. It was cheaper than a big concrete one. When I first went there, we would be going up to the dam and we'd pass a bridge across the Volta river. Some Ghanaians were really impressed by the bridge, and they really wanted us to see it. A Ghanaian friend of mine, who did a post-doc. at UCLA, had seen the Golden Gate Bridge and the Bay Bridge. He said, "Don't bother going up there; it's just a regular bridge." Because he knew what a big bridge was.

We got up to see some of the old forts. At one fort, we saw the secret entranceway where the Dutch governor had quarters up above. The more attractive black slaves to be exported would go up and take care of the Dutch governor at night.

Quivik: What would you say was the--? What did you learn from that experience? How did that experience change you?

Harris: Well, we weren't racist. If we were, we wouldn't have gone. I don't pay particular attention to a person being black. They put on a Gilbert and Sullivan program at a secondary school in Ghana, and I went down to see it. There was a Canadian schoolteacher professing his great love for a black student. It was well into the program that a song came, and all of a sudden it dawned on me, that would really be a real thing to do here, because the Canadian is white and the student is black. But I didn't even notice.

Quivik: Were there any changes that the experience of living in a developing country brought about in you after spending your life in the lap of luxury in the United States?

Harris: I mentioned our hut, what a nice dwelling we had. I picked up a hitchhiker, one of our students, and we talked a little bit and he realized I was okay. He said he'd like for me to meet his folks. We pulled off in this little village, and there was a dirt floor and all. The people were very gracious.

I had a carving, it's since been stolen, about two feet tall from ebony wood. It's of a priestess in ecstasy. It was carved by Dr. Ampofo, an M.D. We used to go out and get eggs from him. He's gone now. We have a nice double-deck Ashanti stool given to me by one of the paramount chiefs. I was visiting him, and I met his daughter in Paris. As I had said, I had given a talk in London. I was wearing a little tie, and it was made out of kinte cloth. One of the speakers from Togo noticed it and said that his wife was from

Ghana. He was living in Paris. I said that we were going to Paris so he gave me his address so we had African food in Paris.

Quivik: Are there people you met in Ghana whom you still see or correspond with?

Harris: Well, a couple years back we got a phone call from a friend. Her son got his Ph.D. here, and was teaching at a community college. I told her that I would pay her airfare from Los Angeles, so she came up and spent five days with us. It turns out, they were five of her last days. A few weeks after she left us, we got a phone call from her son that her body was riddled with cancer and she didn't last.

Our friend, the vice-chancellor of the University of Ghana, he came by and visited us a few times.

Quivik: What's his name?

Harris: Aje Bekway, or Daniel. They have an English and a Ghanaian name.

Quivik: Did the experience you had teaching in Ghana have any effect on your work once you went back to Dow?

Harris: I don't think so; I just got back to the grind.

Quivik: So once you went back to Dow, you started to do your research chemistry again, working on more projects?

Harris: They drive on the right side of the road now, but when we were there, it was the left side.

Quivik: The British side.

Harris: I came home, and my boss, Bob Heitz, said I could use his car. I was toodling around the left hand side of the road. Someone came around the corner, and I thought he was a damned fool. Then I realized, I was wrong and I got over on the right-hand side. Thank God I didn't wreck the boss's car.

Quivik: After you got back to this country, at some point you started teaching at JFK University?

Harris: Yes, I was the head of the science faculty. We only had one department.

Quivik: When did you start that?

Harris: It was about '65 or '66.

Quivik: Can you describe what JFK University is?

Harris: They were going to build a regular campus in Concord. When I was with them, their property consisted of a former mortuary in Martinez. We had six graduates, and the first one is a multi-millionaire now, more than I can say for myself. He graduated with

honors, and he has his own consulting business now. After he got his degree, Dow gave him professional status. He was working in an environmental deal. Then they sent some guy out from Midland whose only qualification was that his wife was from some big-shot family. We had a civil engineer for our mining group, and Dave was ticked off and I don't blame him. He got a job with IT, the group that cleans up highway chemical spills and stuff. So he's the de facto CEO of IT, not the real one. "IT" stands for Industrial Technology, or something.

Quivik: Who was Dave?

Harris: Dave Bauer. Our first graduate.

Quivik: Was JFK just getting started when you began to teach there?

Harris: Yes.

Quivik: What kind of a university was it? Who was starting it?

Harris: Harry Morrison had a big dream. He had a problem getting accreditation because he was the president.

Quivik: Who was he?

Harris: He had started a savings and loan that had almost gone bankrupt. The accreditation people said that a science department really isn't the right thing for the nature of your school. They insisted the science department be part of the Social Studies, and then they were going to shut it down. I wasn't told anything, because Harry was too embarrassed. We had a doroorganic lab. We used Alhambra High School. We bought some kits, and I wouldn't take any person as a student unless they were a lab tech. I knew we could give good lecture courses, but the lab was kind of weak. I ran the doroorganic, and I was satisfied that our experiments were suitable. I don't believe in phony baloney degrees.

Quivik: What was the purpose of this university? What was Morrison's dream?

Harris: I don't know. It was an evening school that gave people a chance to get a college education.

Quivik: How did you get hooked up with it?

Harris: Well, one of the fellows lived next door to Harry. They needed someone to get a science program going. I objected, but they talked me into it.

Quivik: Did you do that as extra work, in addition to the full-time work you were doing at Dow? Did Dow let you do it on their time?

Harris: If I did any on their time, they had no choice.

Quivik: How large was the student body when it got started? A dozen students?

Harris: About a dozen students, for chemistry.

Quivik: Did they call it a university then?

Harris: Yes.

Quivik: But it had less than a hundred students then?

Harris: A couple hundred.

Quivik: Did it give a bachelor's degree? [Harris nods] The students were working during the day and this was a night school opportunity.

Harris: They have a law school, and a lot of lawyers around got their degree from Kennedy.

Quivik: How long did you teach there?

Harris: About five or six years.

Quivik: Did the chemistry class always meet in a high school lab classroom?

Harris: I gave a lecture class and a lab class. In the lecture class, the first three hour class I ever had, I ran out of material in two hours on paper, but I had it up here and kept going. They didn't even notice.

Quivik: Have you done any other teaching besides the University of Ghana and JFK?

Harris: Mercy College.

Quivik: Since the sixties, I should say.

Harris: No.

[Interview 4: October 4, 2001] [Begin Tape 9, Side A]

Quivik: [laughter] This is Fred Quivik again. It's October 3, and we're at the Bancroft Library, and we're continuing the oral history with Guy Harris. Thank you Guy, it's--

Harris: It's the fourth.

Quivik: It's October 4, yes. Thank you.

Harris: Tuesday was my birthday.

Quivik: Oh! Happy birthday. Yes, it's October 4, and we're at the Bancroft Library, and continuing the oral history with Guy Harris. Good morning, Guy.

Harris: Guten Tag, mein Herr.

Quivik: [chuckles] When we left off, I had asked you a question and the tape ran out. So I'm going to ask you that question again. Not counting your teaching with the Sisters of Mercy in Burlingame, we talked, then, at the end of last session about your teaching in Ghana and your teaching with JFK University. Is that the only teaching that you did while you were working at Dow?

Harris: Yes.

Quivik: Yes. Okay, great. Now, I'd like to take a diversion before we get back to your professional activities late in your career, and talk about some of your personal life. We left off with you and Elsie marrying in 1940 and I'd like to review, on tape, your-- the development of your family.

First of all, do you have children?

Harris: Four.

Quivik: Four. And can you tell me their names and when they were born?

Harris: Alice Ann was born in '41. Robert Harris was born in '45, and Mary Harris was born in either '46 or '47. And Sara was born in '51.

Quivik: Four children, and are any of them living near you now?

Harris: Sara is living with us and--since my wife is handicapped, it's pretty convenient because without her, I would not be able to go any--to go on any trips. I would not have been able to go to China in '98. And I wouldn't be able to take the graduate theology classes back at the Franciscan university in Steubenville. It's someone--my wife can fairly well take care of herself [chuckles] but not quite, and--.

Quivik: Let's talk about those years of your children growing up. Can you think about some aspects of your being their father that come to mind?

- Harris: Oh, I was very anti-Catholic for the first forty years of our marriage. And when Alice started school, the teacher was very anti-Catholic and when she would go to catechism, I refer to it as brainwash [laughter], and she'd make Alice stay after school, and also a friend of hers that happened to be Catholic--made them stay after school so they would miss out going to the religious training. And that irked me because I wasn't that keen on them going to catechism, but I thought that was a family affair and not the teacher's business.
- Quivik: This was a public school?
- Harris: Yes.
- Quivik: And where were you living then?
- Harris: Richmond.
- Quivik: Richmond.
- Harris: We lived in Richmond until we moved to Concord in '52. And I think we mentioned my working at Padco so we got the date when we came out and bought the house in Richmond.
- Quivik: So Alice would have been around nine or ten when this was taking place?
- Harris: Yes, we moved there in '45. Robert wasn't one year old yet, when we moved there. And Mary was born in Richmond, and Sara was born in Richmond.
- Quivik: Well, let's get some context here. You say you were anti-Catholic, and Elsie, on the other hand, was a devout Catholic.
- Harris: Yes.
- Quivik: So during those early years of your marriage, how did you maintain that aspect of your relationship?
- Harris: For Elsie, it wasn't easy. [pause] Are we still in Richmond, or--?
- Quivik: Yes.
- Harris: Okay, I had to drive from Richmond--when I went to Dow after one year, five months with Padco I had to drive on the old Highway Four, which took off just north--just east of Pinole, and it's two-lane all the way, and it went over Willow Pass, crawled up. And in foggy weather, it was--it was a pain in the neck driving, and when you'd have a truck creeping along and you're car number thirty-seven, and there are others behind you, it was very frustrating. When I went to work for Dow, my lab bench, the top was wood--two-by-twelves on sawhorses, and--
- Quivik: You mentioned that last time.
- Harris: Oh, I did?

Quivik: Yes.

Harris: Okay.

Quivik: How long did it take you to drive to work?

Harris: Oh, gosh. I--

Quivik: From Richmond?

Harris: Over--about an hour and a half.

Quivik: Wow. Why did you live in Richmond?

Harris: Because that's where we bought our first house when I worked at Padco, down in Emeryville.

And then when I got the job at Dow, my wife--she liked Richmond. She had friends and there's a corner grocery store around the corner, and she could walk to--she and her mother, who lived with us, they could walk to church and they didn't have to put up with my [chuckles] comments about having to take them.

Quivik: And so, despite your anti-Catholic sentiments, Elsie went to church regularly?

Harris: Oh, yes. Yes.

Quivik: And she and her mother--and then as your children were growing up, did Elsie take all of your children to church as well?

Harris: When they ceased to be a nuisance in church, she would leave them home with me. And when they're old enough to behave properly, she would take them to church with her. So Alice used to go with her and I think Robert went while we were in Richmond because he was born in '45, and we moved in '51. Yes, he still stayed home. So I took care of him. That was fairly convenient for Elsie.

Quivik: Yes. Do you remember what street you lived on in Richmond?

Harris: Burbeck.

Quivik: And do you remember the name of the Catholic church in Richmond?

Harris: Saint Mark's. And then they built a new one--Saint Cornelius.

Quivik: And did they build the new one while you were there?

Harris: Yes.

Quivik: So that's the church, then, that Elsie, and her mother, and Alice went to?

- Harris: Supposedly, but they say that they went to Saint Mark's because it was close, so they could walk.
- Quivik: And so, the public school teacher kept Alice after school so she couldn't go to religious education?
- Harris: Yes.
- Quivik: And you thought that was improper because that should be a family matter?
- Harris: Yes.
- Quivik: Can you describe your thinking a little bit further on that subject? In other words, you were an anti-Catholic but you wanted the decision of your daughter's religious education left up to the family?
- Harris: Yes.
- Quivik: Can you elaborate a little bit?
- Harris: Well, I didn't think it was any of that teacher's business. And it wasn't up to her to guide my daughter's religious education or lack of religious education.
- Quivik: And so what was the result of that episode?
- Harris: I don't remember. Elsie and her friend, I think, raised a stink, and the teacher did come out--she had tenure, so she could get away with her nonsense. She came out to Concord and the principal tried to build her up, but it wasn't very effective, and they kept her as a teacher for one year.
- Quivik: In Concord? So she moved to Concord. Was that about the same time that you folks moved?
- Harris: Yes.
- Quivik: Was that just a coincidence?
- Harris: Yes, coincidence.
- Quivik: And was she a teacher for the school where your children were going to school?
- Harris: Yes, but Alice didn't have her as a teacher.
- Quivik: How was it that you knew that that was the teacher's intent--that she was keeping Alice after school so that she wouldn't go to religious education?
- Harris: Oh! It was quite obvious because she wouldn't keep her after school any other days of the week. You didn't have to be a space scientist to draw the picture. [chuckles]
- Quivik: And what was the excuse for keeping Alice after school?

Harris: Oh, I don't know. She could always cook up some excuse--that Alice had talked, or--I don't--this was, that was about sixty years ago, so I don't remember.

Quivik: So then you moved to Concord, and did you move to your present house?

Harris: Yes. You were there.

Quivik: Yes, I've been there. And did you build that house?

Harris: Yes. We had it built, yes.

Quivik: Was it--did you have an architect design it, or was it part of a housing development?

Harris: Well, the contractor built all the houses but one on the street. And he had a draftsman or architect design the house. And I think my wife got in what she liked and didn't like, and so it's--our house's floor plan is like next door to us, where our contractor had built. On my left side, next door, are two bedrooms and we have three, and then had a bedroom behind the garage. Elsie's mother was living with us, and four children. The house in Richmond was very small.

Quivik: What's the name of your street in Concord?

Harris: Georgia Drive.

Quivik: Do you remember any of the particular details of the house that were designed especially for you, that Elsie wanted?

Harris: Oh. [pause] The house next door is--has an entry, a little entry hall, and we do too, but we have two doors between the bathroom and that entry hall, whereas the other didn't have it. And our kitchen is longer than theirs as my wife wanted to have more room in the kitchen because that's where we lived. And then the garage was built a little larger because she wanted adequate space for the washing machine and all.

Quivik: Do you remember the name of the contractor?

Harris: Bud Hanson. We could have gotten a cheaper contractor but we lived in Richmond and we couldn't be there watching everything. And her elder brother commented, "Gosh, he could do anything he wants. And you're not there to keep an eye on him." And I told him, Elsie's brother, that the contractor is more expensive but we could depend on him. We didn't have to worry about any sleazy work.

Quivik: Then, in Richmond, all your children went to public schools?

Harris: Yes.

Quivik: What kind of neighborhood was that that you lived in, in terms of children growing up? Were there a lot of other families with children there?

Harris: This is Richmond?

Quivik: No, in Concord.

Harris: Oh, yes. Yes. Almost everybody on the street had children, except the Swedish couple. And very few children on the street now. You really get to know everybody when you have children, but people move in, we don't even know their names. And they'll live there five years, and move out. We still don't know their names.

Quivik: But during the fifties, you knew them all through your children?

Harris: Oh, yes.

Quivik: Was there a nearby Catholic church that Elsie attended?

Harris: Yes. There's one downtown. Maybe I had calmed down some. But she went to the church downtown. And then they had a new parish and it's over on the next street. Two of the classrooms, or maybe four of the school, or the sanctuary, while that was being built, services were held at the Elks Club.

Quivik: What's the name of that parish?

Harris: Saint Agnes.

Quivik: And is it within a few blocks?

Harris: It's about three hundred yards from us, except it's a three-quarter-of-a-mile drive because of no streets going through--cross streets.

Quivik: Did Elsie and the children walk to church then? Now, you say you'd calmed down. Does that mean in terms of your anti-Catholicism?

Harris: Yes, and well, I wasn't just anti-Catholic. I thought religion was a bunch of baloney. I belonged to a--had belonged to the Masons, and being Mason, you're supposed to believe in God. And I felt guilty about belonging to the Masons because I didn't believe in God. One of my heroes was a very interesting man, he wrote some, what I considered then, simply smashing letters blasting religion.

Quivik: Who was that?

Harris: Oh, God. It will come to me. But he was an internationally known pharmacologist and earlier on, he stood in front of his parish and said, "This is the last day you'll hear me here because I can't preach what I don't believe." And he was an ordained Lutheran pastor. You're a Lutheran, aren't you?

Quivik: Yes. Okay. [laughter] So he had been a Lutheran pastor, and then left the church, and started writing material against religious belief?

Harris: Oh, yes, yes. At one time he was the president of the American Association for Advancement of Science. He was a very good scholar. I don't remember now, his objections but I thought that was really great.

Quivik: Now, in those days did you consider yourself an atheist or an agnostic?

Harris: Well, it would depend upon the weather. [chuckles]

Quivik: And what were the roots of your beliefs, then? The origins? Had you grown up always being a non-believer or did you develop those attitudes in your college years?

Harris: Well, last April--not this year, last year--we celebrated our sixtieth wedding anniversary and the twentieth anniversary of my baptism. So, I was unbaptized until twenty years ago so I didn't belong to any church. My dad was Catholic. My mother was Dutch Reform, and her first husband dissipated a lot of her inheritance. She inherited--had a good inheritance. And he spent it surreptitiously on another woman. My mother finally woke up to the fact, and she divorced him. That was almost a hundred years ago, and divorce was a no-no. And ironical, the woman that her husband was cavorting around with, when my mother dumped her pseudo-lover, she dropped him and went with her lover that she'd had all along. So she's playing both ends. And the only reason she bothered with my mother's first husband was for the money.

Quivik: So, in your upbringing, you weren't brought up in either church--either Catholic or Dutch Reform?

Harris: No.

Quivik: And, in your younger years, did you see any kind of relationship between your profession as a scientist and your anti-religious beliefs?

Harris: Well, I'll skip that for a moment. When in early teens, I think I mentioned my dad's having a problem with employment.

And I think I mentioned the man who got my dad a job over at an industrial ice machine company. He asked my mother--he said he'd like for us to go to the Baptist church where he went. So, my mother was so grateful for the job that she said yes. So we, my sisters and I, went to the Baptist church there, and I didn't mind the summer Bible school, the pastor's commenting that--about Jesus was giving his life for us, and that everything we had took a life. When we ate bread, the wheat seed lost its life, and when we had meat, the animal or the bird lost its life. Even eggs--a potential chicken lost its life. "Not if the egg isn't fertile!" So he put me over with the kids who were shooting spit-wads, and that really irked me. That kind of soured me on--.

I remember once going with my mother to the Presbyterian church. It was *the* in church and I was very young and, as I mentioned before, very insecure, but I was happy to be there because I was associating with "big shots"-- a silly reason for going to church, but I'm sure other people have silly reasons.

[Begin Tape 9, Side B]

Harris: I had a--when I was a junior at Berkeley, I'd gone to church a few times with the family that took care of the house where I lived, the five-story building. I remember standing outside of the church and wondering, what's the purpose, what's the real meaning of life? And I didn't know, but I wondered, and--.

- Quivik: And when you were teaching the nurses in training for the Sisters of Mercy, did you have any religious discussions with them?
- Harris: Oh, oh, no. [chuckling] No, no. I had my Masonic ring on, and it didn't bother them. They believed the same old--I'll keep it clean--[laughter]--that Elsie did, and so--. I didn't bother, and they didn't bother me. There were five nuns in the class; one is alive today, and she's been to the house a few times.
- Quivik: In the early years of your relationship with Elsie, did her Christian faith and your anti-religious feelings cause some serious friction in your relationship?
- Harris: Well, no, because I didn't want her to dump me. [laughter] And we'd go--as I had mentioned, I was a junior at Cal when I met her, and she--after two semesters, the spring and fall semesters, she had her general secondary [credential], and started teaching. It was substitute teaching because in those days, only men got permanent jobs. They had families, they needed it. And we would go out to the beach. We'd take the streetcar, for five cents [chuckle], and we'd go to the zoo. We enjoyed each other's company. And I would go over to see her, and I--she'd have a lot of the homework from the class, to correct it--not do but correct. So I would help her, and organize things, and get it done so we could go somewhere.
- I taught her to use a slide-rule so she could make grades and decide where, which line "C" became "B" and a "B" became an "A". The principal came in to her, and it was a Jewish family, and her daughter had goofed off. The mother wanted the daughter to go to college, wanted a college recommendation grades. So Elsie pulls out her slide-rule and showed [laughter]--and the principal, he didn't know to use a slide-rule. So they were impressed with Elsie. Well, he was, and--but the mother wasn't impressed with that teacher gave her daughter a "C".
- Quivik: So then in the--as your children were growing up, would you say that religious topics were just sort of on the back burner? Or how--did you engage in them with your family, or--?
- Harris: Oh, my daughter Mary--we'd come home, back from Ghana, and I'd come back, and Mary was going to junior college. She said to her mother one day, "Boy, that philosophy class at Diablo Valley is really great. You get your head screwed on right." She said, "I don't believe in that religious baloney anymore." And I wanted to go, "Yeah!" but I knew that Elsie would take her disappointment out on me because the children--your children are on loan to you, but your wife isn't, nor your husband. So I would be the fall guy, besides I'd helped indoctrinate her in her unbelief. It's ironical how she was visiting us about ten years ago, and she, commenting on her unbelief, and said, "Dad, you taught me well." And by this time I had come to the Lord, and it hurt, but it's the truth. You can't deny the truth.
- Quivik: Right.
- Harris: And a few years ago she came back to the church, but she's a doer and she wanted to get involved with the church programs. Our committee-- "We got all the people we need. We got this, we don't need--. We got all we need." And they brushed her off. And you don't brush Mary off.

She's hiking one day and it had gotten dark. She slipped and fell down eight feet into a ditch, and broke both legs. And she crawled up on her elbows to the edge of the road, and a couple men came by. One of them said, "I think there's someone laying down the side of the road." They turned around and, sure enough, there's Mary. They got her to the hospital. Her 911--I don't remember the details. And the two brothers belonged to the Mennonite church. Mary is a Mennonite today. I know we've mentioned this to our Catholic friends. Oh, I tell them we don't care. As long as she knows Jesus, it doesn't matter because he's "the way, the truth, and the light."

Quivik: That's a nice story. Well, let's just hear a brief summary, then, of what each of your children did in adulthood, if you can say. Did they go to college, for instance, and--?

Harris: Alice was a CSF Sealbearer.

Quivik: And what's that?

Harris: Oh, you didn't have children in school here, in high school here.

Quivik: No, no.

Harris: It's the California Scholastic Federation, and you have to have at least three "A"'s and a "B." If you got a "C," you're out. Alice was a CSF Sealbearer and one of the counselors told Alice she wasn't college material. Phi Beta Kappa is the honor fraternity, but Phi Kappa Phi is, too. She went to UOP and they didn't have Phi Beta Kappa. They had Phi Kappa Phi and she was elected to Phi Kappa Phi.

Quivik: And where was that?

Harris: UOP. [University of the Pacific in Stockton.] So she made a national honor fraternity. She had quite a few honors there. She graduated from UOP with high honors. Yes, she wasn't college material. [chuckles]

Quivik: [chuckles] And--?

Harris: Then Robert, he--when we were in Ghana, Robert and Sara went to the international school there. And Mary had a problem with trigonometry and she got--repeated it and still got a "D." So she didn't want--she would have to take that. So the English system is somewhat different from ours. Here, you can select classes in high school, but there you don't. While the whole system you didn't. Robert had taken Spanish but all they had was Latin and French. You couldn't--if you're in the sixth form, you can't take beginning French. The only language available to you is sixth form French. So, Robert dropped the language but he took all the rest, the math and so on.

Mary didn't want to go to the school so we didn't make her. She was taking the required courses in U.S. history by correspondence from U.C. Extension. U.C. Extension is not just college, it's also high school. And she was able to take this required course. Every summer our kids had gone, taken classes. So when she came back--it was her junior year--as far as the fact that she had taken her junior year in Ghana--. So Mary, when it came to graduation time, she had, because of the summer school credits--she had met all her requirements but one for graduation. She didn't have

senior physical ed. And they were, "She's going to have to come back the following year, just for one class." Physical ed. And she told them what they could do with it. [chuckling] She says, "I'll be eighteen in September and the junior college has to take me. So I'll just go out there and start junior college." So they back-pedalled and waived the requirement and she got her high school diploma, and the only one from the official junior class to graduate! [laughter]

Quivik: And where did she go to junior college?

Harris: Diablo Valley.

Quivik: Diablo Valley?

Harris: Yes. And then she went to UCLA and she dropped out her senior year, not because of grades, because she was doing okay, but she got married. [laughter] And Robert, who's older than her, when he came back, he started at Diablo Valley. I refer to it as Pacheco Tech. [chuckle]

Quivik: Why do you call it that?

Harris: Because the old town, the historical town of Pacheco is there. So Robert got sucked into the draft. He went to the communications school and the first six months if he had dropped out, if he didn't make the top level, they would--he'd gotten enough training that you could get a field transmitter receiver and you'd be out in the field over in Vietnam with that. And if you made it to the second, then you were working with more sophisticated equipment and back. If you completed the third, the most difficult, you're over here, or you weren't in Vietnam.

He completed [laughter] the third and he ended up going to Vietnam and he was at the communications center there because he--this is several years later, and is the tail end of the Vietnam War. He spent time in--oh--. When he completed the third term at the school in New Jersey, they sent him to Korea. And the communications center he was at was right on the border. The bureaucrats back in D.C. had plans, instructions, what they were to do if the North Koreans started coming over. But they had their own plan. Their own plan was to grab your knapsack and stuff, run out to the Jeep, get in, lob some hand grenades through the window and get the hell out! [laughter] They heard that the life of a POW [Prisoner of War] in North Korea was not a happy one. He was in for twenty-one years.

Quivik: In the army?

Harris: Yes. Funny thing, the captain didn't like Robert's attitude about something, so he went and complained to the colonel. Well, the colonel says, "Well, Captain, what did sergeant Harris say?" "Oh, he didn't say anything, but his attitude--that's all. Well, yes." And the colonel said, "Captain, Sergeant Harris is doing a damn good job. You leave him alone. That is an order." Robert found out about it because the typewriter jockeys outside the door heard the conversation, and told him. [laughter] So the captain's hands were tied. He couldn't do anything to Robert because when you're given an order, a command is a command. Were you in the military?

Quivik: No.

Harris: Oh, well--. And when he retired, he was at Scott Air Base, and he was at his desk, doing the paper shuffling, and he had his uniform all neat, and pressed, and all. The next day he was a civilian, same desk, civilian clothes, doing the same job. [laughter]

Quivik: So he continued working for the army?

Harris: Yes. And Sara, she applied to just one school and we got her to apply to another. Her counselor said, "You don't have to do that. She's going to get into Cal." And she got--I don't know whether they have the program now, but they did then--she got admission with honors. I wanted her to go into science or engineering and she wanted music. So, she threw the sop to old Dad. She minored in math and she beat out the Chinese-Americans. [chuckles] She went beyond the minimum required for a minor. She majored in music.

Quivik: Music performance, music history, music theory?

Harris: Gee, I don't know. She--this was when all that Free Speech Movement was going on and we were down here, real hippy looking guys going by, "Hello, Sara! How are you?" She was always neatly dressed. BART [Bay Area Rapid Transit] wasn't running when she was here, and she'd take the bus down College and get off at where College ends by the art school, and catch the bus, a Greyhound bus, out. The--one of the buses she caught was a commute bus, and it dropped someone off there, and they couldn't tell her, "Don't get on." And she's sitting next to this business man, and, "Hey, what are all these books for?" She said, "Oh, I'm going to Cal." "You, going to Cal?" The hippy type dress was a common garb at Cal and Sara refused to go as a hippy. [chuckle] When they got the vote while--eighteen years old got the vote while she was here, and my comment is, she's one of the six Republicans registered in Berkeley. [laughter] I don't know how many, but it's a good story.

Quivik: [laughter] So she graduated from here as a music major?

Harris: Yes, with high honors.

Quivik: And does she work in music now?

Harris: Oh, yes. She's been teaching for years.

Quivik: Teaching what?

Harris: Piano.

Quivik: Giving private lessons, or at a school?

Harris: Yes, private lessons. And right now she's working for her master's in a program for teaching children with learning disabilities. It's a special program. Her specialty will be one that is very limited because they've had a problem getting a teacher or mentor with math.

Quivik: Yes.

Harris: And Sara is--if she gets an "A-minus," she's flunking. She's gotten all "A"'s. The program is out of Holy Names and she'll get a master's, but she's also got two or three certificates, state certificates, from UC Santa Cruz. They have classes at Sunnyvale and some of the classes at Holy Names are also offered here on the campus. So she's taking as many as she can get away with but they limit it because they want the tuition money.

Quivik: And where's Holy Names located?

Harris: As you go down 13, you get down around where the Mormon Temple is, it's on the east side--you're going down your left hand side--.

Quivik: In Oakland?

Harris: Yes.

Quivik: How long has she been living with you and Elsie?

Harris: All her life.

Quivik: Really? And, that entire time helping with Elsie's disability?

Harris: Well, it's only the past five, ten years that Elsie's been handicapped.

Quivik: And can you say what that is?

Harris: She had a knee replacement and the guy--well-known specialist--did a crummy job, and he didn't check--. We were told by a specialist in Walnut Creek about twenty-seven percent of the orthopedic surgeons really do a decent check up on that. So she had it done again, and he couldn't understand why he had the x-ray--there's the other knee done by just one of the local guys, perfectly fine, and his job all--the knee was just a mess. When he finished the operation, the x-ray looked fine but he never bothered to see what the knee did when she was walking.

Quivik: So she has a hard time getting around now?

Harris: Yes. She uses a walker, and a wheelchair, and I had those hernia operations. I don't know when I'll be able to lift the wheelchair, but if we go to a restaurant, she needs a wheelchair, and we go to church, she needs a wheelchair. Since my operation, Sara's been going to church and she can handle a wheelchair.

Quivik: Do you have any grandchildren?

Harris: Two. The young lady graduated magna cum laude from Amherst, the number one liberal arts school in the country. Her brother is dyslexic, and that's what got our daughter Sara interested in children with learning disabilities.

Quivik: Whose children are they, your grandchildren?

Harris: Alice's. And the two are it.

Quivik: Where do they live?

Harris: Monterey. Our grandson should get his B.S. in computer science in December.

Quivik: Great.

[Begin Tape 10, Side A]

Quivik: Well, during those years that your children were growing up, then, you remained a non-religious person, if not an anti-religious person. And then you said that about twenty years ago, you were baptized. Can you describe your--conversion experience, we'll say?

Harris: Well, Alice came up with our grandson and she saw her mother and said, "I'm concerned about Dad's unsaved condition and I might talk to him." And Elsie said, "Well, he's your dad." In other words, you know him, and if you want to stick your neck out--but it turned out that she had wanted to speak when she was confirmed as a teenager, when she graduated from high school, when she graduated from college, and when she got married, but the Lord was with her because I would have just cussed her out. But at this time, when she was talking to me, I'd seen--my wife had gone to this Protestant, non-denominational Bible Study Fellowship for five years and it made a big change in Elsie's life because she finally knew Jesus. Up to then, all she knew was Catholicism. Alice had gone five years and made a tiger for Jesus out of her, so they talked. And I said, "Well, I'll do something." "What, Dad?" "Oh--" This is December. I said--

Quivik: What year?

Harris: Twenty years ago.

Quivik: About 1980?

Harris: Yes.

Quivik: Okay.

Harris: So, I said I'll start Bible Study Fellowship in September. Of course it would give me nine months to come to my senses because I'd get these urges on religion, then I'd wise up and-- But, when September came, I went. There were four hundred men going over in Walnut Creek and I went early in the evening to make sure I didn't get on the waiting list. I hate waiting lists. [chuckles] So, [pause] the speaker--you do homework, then they have discussion group because four hundred men can't discuss their homework. Well, the speaker said, "This year we're studying the exciting book of Genesis." I thought, "Oh, God, not the fairy stories," but I stayed. I was quitting when we got to the flood because where does the water come from? The ocean. How can it come from the ocean, come from mountains and come from the ocean when it originally came? I was quitting and something told me, "Don't get lost in the nitty-gritty details. Look for the teaching, the message." So I stayed.

Elsie had been going to a Bible study group at a neighboring parish. A lady used to come down from, over from Clayton and get her but the lady couldn't--this particular day--couldn't take her, come get her. So Sara took her mother and when the Bible study was over, one of the ladies said, "I need a ride--anyone here live in Concord?" "Oh, yes, yes. My daughter will take you." [chuckle] So, the lady said, "Does your daughter take you every day, every time?" And Alice--Sara said, "No." Elsie said, "No," and that--what the deal was, this lady would come and this new lady said, "Well, gosh. That's a lot out of her way, and I live on the way. I could pick you up." So Elsie started going with this lady.

This lady said, "Well, the prayer group down in the neighboring parish, you ought to come to it." And, "Oh," Elsie--her new friend said, "Well, they pray for you, and you need the healing for that bad knee." So she started going, and then one night, Elsie said, "Do you want to go?" And for some strange reason, I said, "Yes." Then on the way down, I was thinking, "Oh, God, what am I doing going down there?" They were Pentecostal Catholics. They were a bunch of noisy kooks and they're Catholics on top of that. For some strange reason I kept going. And one night, I went up for prayer. Frank said, "What do you want prayers for?" I said, "Well, so this religious stuff gets moving." He said, "Okay. Do you want to accept Jesus as your savior?" And I had heard that at the Baptist--they were always on my back, the few years that I went. I thought, I don't know what I came up for, but the other side of my brain said yes. So, nothing happened, so I thought--.

There's a program called Healing Your Memories. Well, the speaker is Father Hampseh.

Quivik: Father?

Harris: Father Hampseh.

Quivik: Hampseh. Can you spell that?

Harris: Say "Ham" and then sneeze.

Quivik: [laughter]

Harris: H-a-m-p-s-e-h. He'd go through a list of people and interacted with--what he was after was bringing out the very hatred that you'd put aside. Then he'd list a bunch of sins, because well, the Lord's Prayer says, "Forgive our sins as we forgive." So he said--when he got toward the end he said, "Imagine yourself in a room and Jesus will come in. He may be a crown of thorns, a robe, whatever, but he's there to help you." So I thought. And someone did come in--a co-worker who had badly wronged me and I'd thought I'd forgiven, but I had not. So, the next day at work, I went and saw him, and I told him, "You know, I thought I had forgiven you, but I have not." And I told him why, and I said, "I forgive you now. I told him why."

Then we're doing the Bible study homework, Genesis, but the--you have a lot of references in the New Testament because it's all one cloth. So one of the references, John 14, in there--Jesus is the way, the truth, and the light, and no one comes of the Father except of Him. So I said to myself, "Gosh, I can accept that." I don't know what

I was thinking, but I said that to myself. Then another reference was the--in Deuteronomy and I don't trust those sneaky Christians so I look above a reference and beyond--get the context. They weren't going to snow me. So, when I got to the beyond part, there's a list of sins. I thought, God, those poor Jews. Everything they did was a sin. They inhaled, it's a sin. They exhaled, it's a sin. They held their breath, it's a sin! And then there were some sins that belonged to me, and I felt very repentant.

Another reference is from Hebrews, that Jesus is the ultimate high priest, and He's the ultimate one for forgiveness of sin. And then I was overwhelmed. Something had me like this. [Gestures with hands around throat.] Did I mention I was told my sins were all forgiven?

Quivik: No.

Harris: Oh, my sins were--I was told my sins were all forgiven. A wonderful feeling.

Quivik: And how were you told that?

Harris: In my mind.

Quivik: Okay.

Harris: And then I was grabbed, and essentially paralyzed, and--but it sure got my attention. I thought, "God, I can't tell anybody this. They'll think I'm a fruitcake." So, at the next prayer meeting I wasn't going to tell anybody. We had a formal discussion group and the leader, the whole group leader said, "What's Jesus done in your life today and this past week?" I was so paralyzed that I couldn't think. If I had my smarts, I would say, "Excuse me, I have to go to the restroom." But--so I tossed a few crumbs out, and they kept after me. They finally got the truth out. That's how Elsie knew what had happened.

Quivik: She was at that Bible study, too?

Harris: Yes. And we'd gone to a weekend retreat--Father Hampseh. I told him what I told you. He said, "Well you're baptized in the Holy Spirit, but you should be baptized with water." That other side of my brain says, "It's got to be immersion." He says, "Well, we're not set up for that." It's the preferred form under Vatican Two, "But we're not set up--," Most parishes are not set up for it. I thought, "Well, that's not going to be a problem for me because it isn't going to be the Catholic church." [chuckles]

Our grandson almost set the house on fire fiddling with the controls on the electric oven, and there's combustible material in the oven. I'd gotten up at two o'clock, smelled smoke, and took care of things in the bathroom and ran down the hall. No smoke by Sara's room so I went out--the kitchen was full of smoke. The next day, I came home from work and scrubbing down the cabinets and all, and Elsie said, "You better get to bed." I said, "Well, I've got to read a couple, just a couple of pages out of the good book." I grabbed her paperback New Testament. On the way into the TV room, where I did my homework--not with the TV on--and on the way in, I did what Bible study fellowship called quick prayer. They said you don't need long-winded

prayer because the Lord knows your need, and all that He wants is that you ask, and that's all.

So, quick prayer, guide us which church to go to. I knew it was going to be a Protestant church because the Lord--I knew at that time the Lord really loved me, and I knew he knew how I hated the Catholic church. So it was going to be a Protestant church. So I went to the top of the page and there's John the Baptist, and Jesus's Baptism, and when it came, the Holy Spirit descended like a dove. Then I--something came to my mind, the story that Father Hampseh told at the retreat. He'd been in a big group of Charismatic Pentecostal--had been in Rome, and Pope Paul was the celebrant, and the dove came down, and circled him three times, and then the dove flew out through the dome window. Then I started getting that squeeze again. I knew the squeeze--He's paralyzing me to get my--so I would recognize just what I--the previous thought was. Someone told me I need the Catholic church. I wasn't thrilled at it, but somehow saying "no" to Jesus didn't seem like a very smart thing to do. So--.

Then the coincidences that happened between that point in time and the baptism--are you interested?

Quivik: Sure.

Harris: Oh. Well, Elsie had told the assistant pastor, you know, about me. So he came for lunch and I told him what I told you. He came with a litmus test. He said, "Elsie, has there been any change in him?" And Elsie said, "Oh, yes. There has." And Sara said, "My Lord, yes!"

Quivik: [laughter]

Harris: I didn't think I was that bad, but I really was. And--

Quivik: So what kind of change? Could you elaborate then, the kind of change that had come over you?

Harris: I just--humble, unproud--which was not what you--I was not what you're looking at now. So, I--the assistant pastor wanted me to come to his program where they're training people for baptism and all, but he wouldn't listen to immersion. So Elsie called this East Indian priest. He was a holy man. He wasn't just--he was a devout Christian. We went down to see him and he gave me an adult catechism book. He knew--forty years living with Elsie, but I didn't know anything about the Catholic church. Well, he knew. He said, "Do you have any questions? Write them down and we'll discuss it."

So this assistant priest--I was going, and dumped Elsie off, and parked the car, came in and said, "Hi, there," to him. He says, "I'm angry," and he said, "In fact, I'm mad." Then he says, "I'm going to the bishop," because I wasn't going to his program, Right Christian Initiation for Adults, RCIA. Not--"C" is not Catholic, it's Christian. The Catholic church has finally wised up since Vatican II. I told Elsie, and she says, "He's going to the bishop? We've got to go see Father Dennis." So we went down to see Father Dennis. The guy gets through the book in one week? Oh, no. We've got a big problem. We told him, and he said, "You have no problem," and he says, "The

immersions are the preferred form of the Vatican II. He reiterated it. He said, Maybe it'll teach him a thing or two," meaning me.

We went--the assistant was going to the Holy Land and spend a month at an Anglican seminary there in Jerusalem. So they put on a special program for him with champagne, and raised money. Elsie said she heard him saying, "Oh, those Harrises are preaching at me!" Eventually--oh, I'll stick to him. I won't just follow everything in the time line. We had gone to a winery up in Napa, and I picked up a little thing like a chalice. I gave it to him, and I got a thank-you note from him, and he said--I had mentioned that we'd be praying for him while he was in Jerusalem, and in this letter he said, "I've been praying for you, and thank you for the spiritual help you've been to me." So Father Dennis was right. [laughter] But, this friend that I've belatedly forgiven, his son went to a church in Walnut Creek that did both forms--the sprinkle, or the dunk. My friend's son had asked the pastor--"Yes, that would be fine. He can--Father Dennis can come." So--.

Quivik: This church was not a Catholic church?

Harris: Oh, no.

Quivik: Father Dennis, and the assistant priest--are they at the local parish there in Concord?

Harris: Father Dennis had been an assistant at Elsie's parish, there. Saint Agnes. And Father John Lydman, the one who got uptight, the assistant at Saint Agnes--so I had gone to the book, and one thing that really bugged me--the Pope stuff. I thought, well, I just can't hack the authority of the Pope. I said, "Lord, I've had it." Well, the next day, as we're reading the paper, a couple of Catholic theologians had mouthed off about something, and you'd agree, God, those guys are horse's necks, moving up from the back to the neck. [chuckles] And the Pope told them to knock it off and be quiet. He shut them up. Now, if they were Baptist, no one could have shut them up, but the Pope did it. So that took care of that.

So Father Dennis says, "Name the time and place. I'll be there." I got--went and got in touch with my friend. The secretary says he's gone back to company headquarters for a week. Then the following week, I forgot to call him. Monday and Tuesday I called him. The secretary says he's in Sacramento, he won't be back until Friday. So, when Friday came, I got the phone number of the pastor. I didn't want to call him because his work was cut out for him for the weekend. Monday I called and the pastor's son answered. I said--he said his father wasn't there. I said, "I'll call him when he gets back." "When's he going to be back?" "He won't be back for two weeks." He's a Navy chaplain, yes. I thought, "Oh, God, two weeks." And I might find out that they're not going to have any immersions for a month or so.

So I was coming home from work grumbling. "Lord, you got me in this mess, You've got to do something." When I got there, a friend from the prayer group was at the house, the only time she was ever at the house. As I was grumbling away, she said, "We could go over to Assembly of God Church--they're charismatic--and see the pastor." And, as she was talking, I knew that was it. So I went and he wanted to know what brought us there, so I told him my story. He said, "Yes, you can use it."

Well, we bought a large sheet cake because about eighty-five people came. When they put the cake in the trunk, the bakery guy said, "It's covered with cream. You've got to keep it refrigerated." "I thought, oh, that's no problem." Two or three of our neighbors had deep-freezes. They had all--kids had left home, and they'd gotten rid of their deep-freezes.

[Begin Tape 10, Side B]

- Harris: So I called the Assembly of God Church, and the fellow said, "Oh, yes. We have a large refrigerator." I went and it cleared. Coincidentally it cleared front and back. And before we left, the gentleman said, "By the way, you're lucky. I'd forgotten something. Normally, there's no one here at this time, but I forgot something and had to come back." Coincidence? Well, they let us, he says, charge for the sanctuary just for the hot water, but the fireside room, no charge.
- Quivik: Were these eighty-five folks from your prayer group, or your Bible study group, or from the local parish--?
- Harris: Oh, people from work, and a lot of Protestants, and the--[laughter] I think a lot of the Protestants from work came to see is this really going to happen?
- Quivik: [laughter] Because they'd known you all those years?
- Harris: Oh, yes. So Father Dennis came, beautiful robe, and I said, "Where'd you get wet clothes, Father?" "Ohh." So I went home to get some old clothes for him. I was coming up Farm Bureau Road there, and someone starts speaking to me, "Why don't you just turn around and go back? They'll get over it. Just turn around and go back. They'll get over it. You know you don't want to become a Catholic". You don't have to do much guessing to know who was speaking to me.
- Quivik: Yes. What day of the week was this, by the way.
- Harris: Sunday. Palm Sunday.
- Quivik: Palm Sunday? For the regular Sunday service, or was this later on Sunday after--?
- Harris: Sunday afternoon. There are other things, coincidentals that don't come to mind right now, but--.
- Quivik: So you were baptized twenty years ago, and it was at an Assemblies of God Church, but since then you've been active in your local Catholic congregation with Elsie?
- Harris: Yes.
- Quivik: And how did she like that?
- Harris: Well, she was thrilled. She was thrilled at the baptism of the Holy Spirit because I had accepted Jesus and He had accepted me. That was enough for her. That's the most important thing.

The rest--oh, we had Seventh Day Adventist friends and they're very anti-Catholic, the Adventists. We had a fig tree and one of the visiting clergy at the Adventist Church liked figs. When he found out that he was going to get them from a Catholic, he didn't want any. [laughter] One day she said to me, "Oh, you people worship the sun God. You go to church on Sunday." I said, "Oh, you must worship Saturn. You go to church on Saturday." Elsie said, "Boy, she's never going to forgive you for that." You'd tell her something, and "Oh, no. You're wrong." every time, almost every time. "Oh, no. You're wrong. Oh, no. You're wrong." So, one day, I thought I'll set her up. "You know, Marion, the Catholic church hasn't saved anybody." Her face went up. I knew I had her, and I said, "Neither has the Seventh Day Adventist church saved anyone. Jesus is the one who saves. She didn't say I was wrong." [laughter]

Quivik: Well, you mentioned a bit ago the Franciscan university in Ohio. Can you describe how you came to be involved with that university?

Harris: Well, one of their faculty had a TV program, and channel 42 used to be a Christian station. This priest was on the--had a program on this station, and he's commenting about the school back there where he was teaching. So I got involved in sending more money, and sending them more money, and I sent a check to the president of the school, Father Michael Scanlon. In the letter I said I wanted it to go to the chemistry department *above* budget because if it's budget, all you're doing is letting it go anyplace because above budget doesn't really mean anything. It does--I'm sorry--it *does* because it's extra money for the chemistry department. I said that I've only been a Christian for four years but I've been a chemist for forty years and old habits die hard. I wanted it to go to the chemistry department.

Last October I was invited back. They paid my airfare. They paid for my hotel. The young man that picked me up took me to the hotel and I had dinner. He said, "Dr. Liver, she would like to--(head of the chem department)--she would like to see you at the new science building." So I went. We went up to the top floor, the *top* is the best for--for the best, the chemists. [laughter] Don't tell Fuerstenau. [chuckles] So, we came out of the elevator and there's a crowd down there in the hall and they started singing "Happy Birthday" because, coincidentally, it was my birthday. So it was a little over a year ago. So after we had done severe damage to the sheet cake, she started reading my attributes--the patents and all that stuff. Then she went up and took a cloth off the wall, and there's a bronze plaque, "The Dr. Guy Harris Instrument Lab." Someone said to her, "Boy, that is a long list you had, there." She said, "No, I kept it brief." [chuckles]

Quivik: So you've been donating to that university for roughly fifteen, sixteen years?

Harris: Yes.

Quivik: And they named the instrument lab after you. Congratulations.

Harris: And I've taken four graduate theology classes there.

Quivik: Yes. They have a seminary that's part of the university?

Harris: No, they have a theology department.

Quivik: What particular aspect of theology are you interested in?

Harris: Oh, just curious. I had to write--the first class, I had to-- we had to write three papers. The last class I took for credit, three papers. Second paper, I only got a "B-plus" and I said, "Dr. Shrek, what can I do to improve my grade?" He said, "Stop writing them like technical reports."

Quivik: [laughter]

Harris: So they--two years ago I took a class in the teachings of Vatican II. We had to write three papers. Each paper, "A," excellent, "A," excellent, "A," excellent.

Quivik: So you're learning to broaden your writing style?

Harris: Yes.

Quivik: Good. But you continue to work on technical papers as well?

Harris: Yes. Well, actually, I was co-author on five.

Quivik: Last year?

Harris: Last year.

Quivik: Well, I'd like to talk about some of those technical papers, but to get to that point, I'd like to take you back now to your retirement from Dow Chemical.

Harris: In 1982.

Quivik: And what led to your retirement?

Harris: Well, I was going on sixty-eight, and I would have to retire when I was seventy.

Quivik: That's company policy?

Harris: And I didn't want to stay till I was seventy because it looked like too much a company man. And they had a bonus for people who retire early. If you're over sixty-five, it's only four months pay, but--. And I had done my "infernal" revenue 1040, and did a little calculating. I wasn't going to lose much, and in the four months it would be a big--take the sting out. Another--a friend of mine was quitting. He was only sixty-two. I was sixty-eight and--. I did some consulting with a company down in Arizona. And also--

Quivik: What kind of a company?

Harris: Making chemical reagents.

Quivik: What's the name of the company?

Harris: It was Kerley Chemical.

Quivik: And reagents for the mining industry?

Harris: Yes. So I was working--I was even on the Penn State payroll for two weeks. I made twenty-seven or twenty-eight reagents in two weeks.

Quivik: Was that immediately after your retirement from Dow?

Harris: Not immediate, but essentially immediately.

Quivik: Okay. Can you describe how you established a relationship with Penn State University?

Harris: Oh, one of the fellows at Dow was a de facto professor, it means the same thing.

Quivik: Adjunct?

Harris: Adjunct professor. And, Fuerstenau knew him well. And I was supplying reagents for a graduate student, and she's working on a program that Klimpel helped design.

And the graduate student was Patrice Ackerman and her thesis--the reagents made by or under supervision of Dr. Harris. Reagents made by--you know they all, all of the reagents were made by me or under my supervision.

Quivik: At Dow?

Harris: Yes. And so she turned out a lot of work because she didn't have to spend time making reagents. Two of the papers last year I was co-author on for Penn State, and one of the papers is taken from a patent of mine from Dow. Then the remaining two was the work of coal here, that we'll get to.

Quivik: Back then, when you started working with Penn State through Klimpel's contact, was it when were you on the payroll at Penn State? Was that to work with this graduate student, to help her with the work she was doing?

Harris: Yes.

Quivik: And you've worked with Aplan at Penn State?

Harris: Yes, Professor Frank Aplan.

Quivik: And is that when you first started working with Professor Aplan?

Harris: No. I had gotten involved with him while I was still at Dow.

Quivik: Earlier? And what's his field of study?

Harris: Oh, Fuerstenau's.

Quivik: Extractive metallurgy?

Harris: Yes. I haven't had a chemical paper in eons! [laughter] It's just been mineral reagents.

Quivik: Then you've also worked with Doug Fuerstenau here at Cal.

Harris: Yes.

Quivik: How did you first come in contact with Doug?

Harris: Well, first contact was in '63. I had gone up to the International Mineral Processing Congress meeting in Cannes, France. I went up from Ghana while I was teaching at Ghana, but Dow paid the expenses. I had to get permission from the professor, the head of the department. I said Dow's paying for it. "Oh! Go on, go! Yes, yes, yes." He thought when the University of Ghana had had to pay for it, he didn't know how he was going to justify it but when Dow paid, fine--because this way, another thing on the annual report for the department, someone had gone to a technical meeting out of the country, and--.

Quivik: So you met Doug there?

Harris: Yes. And he and a co-worker, Elmer Tveter--and they--we may have mentioned--?

Quivik: Yes.

Harris: And Elmer bought a Mercedes diesel, and we went up, and visited the place. I'll think about it, and in a day or two, where we went. I think it was Grasse, known for it's perfumes. And so I'd stopped by here to see Doug, and one of my students from Ghana went to the Royal School of Mines and got his M.Sc. and D.Phil., (Ph.D.). When he'd finished, he'd come out and spent three weeks with us. He flew over and he wanted to see Fuerstenau's department, so I called Doug. He says, "Bring him down." I called my friend George Parks at Stanford and he says, "I'd like to show you our department, if we only had one," because Stanford had dropped the mining department.

Quivik: Yes.

Harris: Although it got its fame from Herbert Hoover. And in '88 I happened to stop by and see Doug. As I was walking out, Doug said, "God dammit Harris. I should have put your name on the D.O.E. proposal I just sent in. I think I can still add your name--do you mind?" And I said, "No." A week or so--a week later, I got a phone call from Penn State, "Guy, I'm sending in the proposal to the Department of Energy contract, coal research, and I'd like to put your name on it." I told him, "Too late."

Quivik: And that was Aplan?

Harris: Yes. So--.

Quivik: You got the grant, or the contract?

Harris: Yes.

Quivik: And what was that to do?

- Harris: Coal processing--went on for a good three years. They had a big army there because he had money. [chuckle]
- Quivik: And were there graduate students? Can you describe what kind of coal processing you were working on?
- Harris: We had high rank and moderately low ranked coal, and one in between. Pittsburgh number eight, Illinois number six, and the third one.
- Quivik: And when you're saying, talking about rank, you mean from--bituminous to sub-bituminous to lignite?
- Harris: Anthracite. High ranked.
- Quivik: Yes, that's the highest. And did you go as low as lignite?
- Harris: No, no.
- Quivik: Sub-bituminous?
- Harris: No. Illinois number six was somewhat--it wasn't exactly high-ranked--
- Quivik: Yes, but it was bituminous coal?
- Harris: Yes.
- Quivik: Okay.
- Harris: And out of this came, from here, my idea--two classes of collectors for low-ranked coal, and there are no, other than ours, low-ranked coal collectors. I think the use has been fuel oil, that type of collector, and standard frother, MIBC, very common. But our two classes--the collector really worked.
- Quivik: And, can you say what it is you were trying to accomplish there, in employing these collectors?
- Harris: Well, you get rid of the--a lot of the ash and we were trying--the main goal was pyrite because that's about fifty-five percent sulfur and the acid rain is from the SO_2 , SO_3 smelters and power plants.
- Quivik: So this was intended to be a way of treating finely pulverized coal, and separating ash, and/or sulfur compounds from the hydrocarbons?
- Harris: Yes, and we were also--they, the big wheels and the D.O.E., they really tied our hands. We had to do this, we had to do that. They came up with the idea of free radicals--well, utilizing the free radical concept. So they wanted us to come up with some free radical initiators. So I figured you had to use something common, cheap. Fuerstenau likes--he doesn't care. But my years at Dow, if it isn't economical, forget it.

So I used styrene as an initiate to the free radical polymerization. What they figured it'd take a monomer like that and when you're grinding the ore, you're breaking carbon-carbon bonds, and you're generating free radicals. This monomer polymerizes on the surface. So I took the styrene, and the methyl-acrolade, and a couple other things that don't come to mind at the moment. These monomers are going to have some collector properties of their own. So I took ethyl benzene and if there are no differences between the impact of ethyl benzene and styrene, you don't have anything. Well, they hadn't even thought of that. They were really impressed with what we had done. We--.

It's funny, no one claimed any credit for the idea to begin with.

Quivik: No one did?

Harris: Not after--after our work, showing that the concept was fallacious. No one wanted to say, "Hey, I came up with a bum idea." No way.

Quivik: Well, I'm confused. Was it a bum idea?

Harris: Yes. It didn't work.

Quivik: Oh. It didn't work.

Harris: Because the ethyl benzene and the styrene behaved as the same when it was added to the ball mill. And I figured, probably--

[Begin Tape 11, Side A]

Harris: The coal is a poly-cyclic, aromatic system. Then you break the carbon-carbon bond--yes, you will get a free radical, but if you take hexa-phenyl ethane, there's a phenyl on each valence available on the ethane hydrogen. It's a nice crystalline solid, but if you use a solvent, and, say, benzene re-hydrocarbon, the solution becomes yellow and what you have there is a phenyl-phenyl-phenyl-methyl free radical, and that free radical--the electron gets what we call de-localized into the benzene rings. The solution, the stable form, is the free radical de-localized into the three--the carbon-carbon bond two electrons, when it breaks you have one, you've got a free radical, and it's stabilized by residing into the three benzene rings. The problem with all this poly-cyclic--you break a carbon-carbon bond, that electron just wanders off into the poly-cyclic system that's available in the particle.

Quivik: And so, the net result is that--what? You're not able to use it, use this--

Harris: Concept.

Quivik: --concept as a way of separating the ash or the sulfur from the carbon--?

Harris: Not the ash, the--

Quivik: That can be separated--

- Harris: You're not enhancing the flotation process by the styrene reacting with that free radical, and building a polymeric coating.
- Quivik: Okay. So the net result of that work was to show that the process would not be effective.
- Harris: But no one wanted to take credit for having made--[laughter]--came up with a concept that didn't work.
- Quivik: Yes. Well, you spent a lot of money to demonstrate that there was no point in further research, right? [laughter]
- Harris: Yes, and they didn't push it. [laughter]
- Quivik: Have you worked on other coal-related projects since?
- Harris: Oh, yes. In '93, I--the first class of low-rank coal collector--I gave a paper in Reno at the SME meeting.
- Quivik: And just in case we haven't got this on tape yet, what's SME?
- Harris: Society of Mining Exploratory Engineers.
- Quivik: Okay. So you gave a paper and you've continued this coal work from '91 onward?
- Harris: Yes.
- Quivik: And with Doug [Fuerstenau], working with Doug?
- Harris: Yes. Doug really liked it, the second class, and he ran with the ball. [chuckles] So, he needs it more than I do. [chuckling] Yes, and someone in Australia became aware of our work and they did some, I think, not just simple lab tests, but big tests and they said, "It's great."
- Quivik: Have you worked on projects, either through Cal or Penn State, with other mineral activities besides coal, since you retired--?
- Harris: Oh, yes. The stuff at Penn State was--we had five minerals: chalcopyrite, chalcocite, --we--
- Quivik: Enargite?
- Harris: Well, anyway we had--
- Quivik: All copper minerals, anyway.
- Harris: Yes. Four, and the fifth was pyrite. And you looked to see if you could come up with something that was good for copper, but not for pyrite flotation. Patrice used a pure mineral to determine the velocity of the kinetic speed of the flotation.

Quivik: This is that work you were doing shortly after you retired from Dow.

Harris: Yes, at Penn State.

Quivik: Besides those two connections, the University of California and the Penn State connections, have you done some other professional work since you retired?

Harris: No. I retired in '82. Dow went out of the business in '79, so I did some consulting while I was still at Dow. I would take the time and charge it off against vacation, but I'd get paid by the other. I went out to General Mills Mining Company, and I went up to Minneapolis, and they wanted to retain me as a consultant. They wanted to go into the mineral reagent business.

Quivik: You mean General Mills, the company that mills flour, and makes cereal, and so forth?

Harris: Yes. They were making the best LIX reagent, solvent-extractive reagent for copper, or solutions of copper.

Quivik: Hmm. What kind of reagent? You said LIX?

Harris: Yes. Liquid ion exchange.

Quivik: Oh, right. LIX, right. General Mills was making that.

Harris: And they sold the company off. I told--I'm slitting my own throat but I can't recommend that you get into the reagent--go into the reagent business. A few years later I saw my friend Joe House and he said, Thank you for giving us the right steer.

Quivik: [chuckles]

Quivik: What I'd like to do now, Guy, is turn to some broad, overall, evaluative questions and ask you if you could put your career as a chemist in context. What would you say your contribution to the field has been?

Harris: Well, my contribution to the pharmaceutical--the work has continued for about five years after I left. I was still working on my ideas.

Quivik: Was the poultry feed related to cocciliosis?

Harris: No, it's the William S. Merrill Company in Cincinnati. Dow bought them out and then Dow sold them to, I think Bayer, and Bayer just shut the lab down.

Quivik: Oh, okay. I'm sorry. This goes back to your work in Cincinnati. All right, gotcha.

Harris: They were making this reagent using my process and it's something--since I wasn't there, I wasn't privy to everything that went on, but there were a lot of publications and all, not with my name on it. They had a policy of, if you weren't there, you weren't part of their team.

Quivik: Yes.

- Harris: I guess it was a real good reagent but not *very* good so it didn't make it. Then the Z-200, we discussed that earlier, how much copper in one year it saved for mankind. Then I had a real good reagent but it was mis-marketed. The middle management guys wanted to make big bucks so they could get a lot of credit.
- Quivik: Which reagent are we talking about now?
- Harris: The 2-11. It was mill-trialed at Falconbridge. The price they were talking to Falconbridge initially, the company could make good money, but the middle management guy wanted to make big bucks so he could leap-frog up the ladder. There was another nickel reagent that was mill-trialed in Australia, but the ore contained mica and the Dow sales representative didn't know how to handle the problem. He should have gone back with polyglycol 400 and that would have handled the mica problem, but we didn't always get top flight metallurgists.
- Quivik: Why do you think that your Z-200 did not fall prey to middle managers pricing it out of the mining companies' reach?
- Harris: Well, Elmer Tveter was the one that got it moving, and, back in the fifties, we were getting a dollar a pound for it. So that was big money and the mining--regular chemical business has its ups and downs, but the mining doesn't go with it. One time the profits, the only profit for the western division was the Z-200 because all the caustic chlorine and the other products of Pittsburgh weren't making any money because business was bad. Then the frother--I think I mentioned the success of the mill trial and at fifty-five cents a pound, you could make good money, but the middle management guy wanted seventy-five.
- Well, that was my fate. Being stuck--I couldn't make--if a new reagent was going to require a new plan, Dow wouldn't touch it because they had one plan already. I remember at an SME meeting in San Francisco, the, our big competitor was American Cyanamid, which is now Cytech. This young man was in charge of their reagent development crew. He says, "Oh, you're my counter part at Dow. You're like me, you're in charge of the reagent development group." I said, "I *am* the reagent development group."
- Quivik: So all of those different chemicals that you developed--would you rate Z-200 as the most successful, or having the most impact?
- Harris: Well, yes, because it's the only one that really got sold. The frother would have made big money for Dow, and also, would have been a boon for mankind.
- Quivik: It was just priced wrong? Is that the main reason it didn't succeed, do you think?
- Harris: Well, it was mill-trialed at Morenci [Arizona] and the mill superintendent had been assured that the price would be fifty-five cents a pound. So when the middle management guy saw the results of the mill trial--seventy-five cents a pound.
- Quivik: And then, in terms of that span of the development of reagents, frothers, etc. Was there any kind of approach that you took to developing those that you think contributed either to the larger industry or to the way that Dow thought about that kind of development

work? Would you put any of your work in that category--that it helped change the course of development?

Harris: I don't see how you could change anything with the middle management people we had. The mining people kind of called the shots in the beginning. Then, when they started bringing outsiders in charge of the mining group--.

Quivik: Where were those outsiders from?

Harris: Oh, civil engineer in charge of the mining group, and--.

Quivik: Were they also from outside the company?

Harris: No, no, no.

Quivik: They were just outside the field?

Harris: Outside the field. Yes. If I had gone to work for American Cyanamid, I'd have been a real big hero.

Quivik: [chuckles] And is that because their business was focused?

Harris: Run as a business should be run.

Quivik: And how--could you characterize that? How would you describe that?

Harris: He said--he said, "You look and what it costs you to make, and then a reasonable profit. If that reasonable profit--the reagent can do something for the company, the mining company, they'll buy it."

Quivik: And the folks at Dow didn't run it that way?

Harris: No. At first they did but Elmer Tveter got fired in '58, '60, and became--and the former, retired research director, at Western got him back. And he--we always worked together. His strong suit wasn't chemistry, but he had me and I had him. We made a good team.

Quivik: Was that relationship, that working relationship with Elmer--would you consider that you be your top one of career at Dow?

Harris: I'd have been less effective with someone else and they would've been less effective.

Quivik: Okay. Well I think we've covered most of the bases and I thank you for this interview, Guy.

[End of interview]

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Dr. Guy H. Harris

1673 Georgia Drive
Concord, CA 94519

Education

B. S., Chemistry, University of California at Berkeley, 1937
A. M., Chemistry, Stanford University, 1939
Ph.D., Organic Chemistry, Stanford University, 1941

Professional Experience

1937 - 1938 Analytical Chemist, Shell Development Company
1941 Post Doctoral Researcher, Stanford University (with C. R. Noller)
1941 - 1945 Organic Chemist, William S. Merrell Company
1945 - 1946 Organic Chemist, Fibreboard Products Company
1946 - 1959 Organic Chemist, Dow Chemical Company
1959 - 1982 Associate Scientist, Dow Chemical Company (flotation reagent design, synthesis and process development)
1962 - 1964 Senior Lecturer, Chemistry Department, University of Ghana (on leave from Dow Chemical Company)
1982 - Consultant for Dow Chemical Company, American Cyanamid, Henkel, I.T. Corporation, Kerley Mining Chemical, Pennsylvania State University (consulting plus reagent synthesis)
1988- Visiting Research Engineer, University of California at Berkeley (Coal desulfurization by advanced flotation, coal flotation reagent development, pyrite depressants, nonmetallic mineral collectors)
2000- Honorary Professor, Huainan Institute of Technology, Huainan, China

Professional Society and Related Activities

Royal Society of Chemistry (*Fellow*)
Society for Mining, Metallurgy and Exploration, AIME (*Distinguished Member*)
American Chemical Society
West African Science Association
American Association for the Advancement of Science (*Fellow*)
Sigma Xi, Phi Lambda Upsilon

Research Interests

Mining chemicals (design of flotation collectors, depressants, frothers)
agricultural chemicals, pharmaceuticals

FLOTATION-RELATED PUBLICATIONS OF GUY H. HARRIS

(40 TOTAL)

- "Xanthates," Kirk-Othmer Encyclopedia of Chemical Technology, 2nd Ed., Interscience, New York, pp. 419-429 (1970).
- "Effect of Alkyl Substituents on Performance of Thionocarbamates as Copper Sulfide and Pyrite Collectors." (with P. K. Ackerman, R. R. Klimpel and F. F. Aplan), Reagents in the Minerals Industry, M.J. Jones and R. Oblatt, Eds., The Institution of Mining and Metallurgy, London, pp. 69-78 (19784).
- "Xanthates," Kirk-Othmer Encyclopedia of Chemical Technology, 3rd Ed., Interscience, New York, pp. 645-661 (1984).
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- "Evaluation of Flotation Collectors for Copper Sulfides and Pyrite, II. Non- Sulfhydryl Collectors," (with P. K. Ackerman, R.R. Klimpel and F. F. Aplan), International Journal of Mineral Processing, Vol. 21, pp. 105-127 (1987).
- "Evaluation of Flotation Collectors for Copper Sulfides and Pyrite, I. Common Sulfhydryl Collectors," (with P. K. Ackerman, R.R. Klimpel and F. F. Aplan), International Journal of Mineral Processing, Vol. 21, pp. 129-140 (1987).
- "Evaluation of Flotation Collectors for Copper Sulfides and Pyrite, III. Effect of Xanthate Chain Length and Branching," (with P. K. Ackerman, R.R. Klimpel and F. F. Aplan), International Journal of Mineral Processing, Vol. 21, pp. 141-156 (1987).
- "Principles and Practice of Sulphide Mineral Flotation," (with D. W. Fuerstenau, R. Herrera-Urbina, and J. S. Hanson), in Sulphide Deposits -- Their Origin and Processing, P. M. J. Gray, Ed., Institution of Mining and Metallurgy, pp. 87-101 (1991).
- "Coal Flotation with Nonionic Surfactant Collectors," (with D. W. Fuerstenau and J. Diao), Preprint No. 93-241, SME Annual Meeting, Reno, NV (1993)
- "Coal Flotation with Nonionic Surfactants," (with D. W. Fuerstenau and J. Diao), Coal Preparation - A Multinational Journal, Vol. 16, pp.135-147 (1995).
- "Surface Chemistry and Rheology of Pittsburgh No. 8 Coal-Water Slurry in the Presence of a New Pyrite Depressant," (with F. J. Sotillo and D. W. Furestenau), Coal Preparation: A Multinational Journal, Vol. 18, pp. 151-183 (1997).
- "Nonionic Surfactants as Collectors for the Flotation of Oxidized and/or Low-Rank Coal," (with D. W. Fuerstenau and R. Jia), in Surfactant-Based Separations, J.F. Scamehorn and J. H. Harwell, Ed., ACS Symposium Series 740, American Chemical Society, Washington, DC, pp. 230-247 (1999).
- "A New Family of Flotation Reagents for the Depression of Pyrite: A Clean Technology for an Old Problem," (with J. Sotillo and D. W. Fuerstenau), Clean Technology for the Third Millennium Challenge, Proceedings of the International Mining and Environmental Congress, Lima, Peru, pp. 99-116 (1999).

"An Improved Class of Universal Collectors for the Flotation of Oxidized and/or Low-Rank Coal," (with R. Jia and D. W. Fuerstenau), International Journal of Mineral Processing, Vol. 58, pp. 99-118 (2000).

"Use of Xanthogen Formates as Collectors in the Flotation of Copper Sulfides and Pyrite," (with P. K. Ackerman, R. R. Klimpel, and F. F. Aplan), International Journal of Mineral Processing, Vol. 58, pp. 1-13 (2000)

"An Improved Class of Flotation Frothers," (with R. Jia), International Journal of Mineral Processing, Vol. 58, pp. 35-43 (2000).

"Chemical Reagents for Enhanced Coal Flotation," (with R. Jia and D. W. Fuerstenau), Coal Preparation: A Multinational Journal, Vol. 22, pp. 123-149 (2002).

GUY H. HARRIS FLOTATION REAGENT PATENTS

(51 total number of patents)

Dialkyl thionocarbamates. U.S. 2,691,635, 12 Oct. 1954.

Thiono Compounds and Their Use as Flotation Agents. U.S. 3,590,996, 03 July 1971.

Thiocarboxylic Esters as Flotation Aids. U.S. 3,590,996, 03 July 1971.

Flotation of Sulfide Ores. U.S. 3,590,998, 06 July 1971.

Flotation of Sulfide Ores. U.S. 3,590,999, 06 July 1971.

Bis (cyclic alkylene) pyrophosphates. U.S. 3,579,511, 03 Aug. 1971.

Hydroxy Alkyl Phosphates and Polyphosphates. U.S. 3,652,743, 28 March 1972.

Preparation of N-Alkyl-Thioalkyl-O-alkyl Thiocarbamate. U.S. 3,772,345, 13 Nov. 1973.

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June 14, 2002

Dr. Edward C. Dowling
 Chairman, AIME Frank Aplan Award Committee
 Cleveland-Cliffs Inc.
 1100 Superior Avenue
 Cleveland, OH 44114-2589

Re: Nomination of Dr. Guy H. Harris for the 2003 Frank F. Aplan Award

Dear Dr. Dowling:

I write to nominate in the highest terms Dr. Guy H. Harris for the 2003 Frank F. Aplan Award of AIME. Of living chemists involved with mining chemicals, there probably is no one worldwide who has had the impact on flotation reagent synthesis that Guy Harris has had. He has shown the way to design and synthesize new reagents to achieve improved flotation results, primarily for the flotation of sulfide ores but also for the flotation of coal.

He is known worldwide for his work in flotation reagent synthesis and is quite likely the most knowledgeable synthesis chemist in the field, with his experience extending back about 60 years. Most of his long career was with the Mining Chemicals Division of Dow Chemical Company, from 1946 until his retirement in 1982, where his major concern was with flotation reagent design, synthesis and process development. He has published some 35 papers (including 7 major book chapters) and in the past decade or so has made more than a dozen major technical presentations for SME, IMPC and other international symposia. In 1999, he was invited to China where he presented a series of lectures in Beijing and Huainan on reagents for the flotation of sulfide minerals and coal. Though retired from Dow Chemical Company in 1982, he has remained active in research on flotation reagents, first at Penn State and then at the University of California at Berkeley. To this day, at the age of 88, he spends a day a week at Berkeley working with graduate students on the design, synthesis and testing of new reagents for mineral and coal flotation.

His invention of Z-200 (a dialkyl dithionocarbamate, U.S. Patent 2,691,635) is undoubtedly the most significant sulfide flotation reagent development since the invention of xanthate as flotation collector by Keller in 1923, followed by the

dithiophosphates shortly thereafter. The impact of Z-200 on sulfide ore flotation, and particularly copper ore flotation, can be illustrated with data for 1979 as an example. In 1979, 10 million pounds of this reagent (and its copy by other producers) were sold worldwide. At a reagent consumption of 0.02 - 0.04 lb/ton, there is an increase in copper flotation recovery of +2 %. With the treatment of about 330 million tons of copper sulfide ores worldwide and assuming a grade of 0.6 % (an underestimate), this means that Guy Harris' invention has given the world an additional 80 million pounds of copper annually — an incredible achievement.

For a number of decades, with Elmer Tveter and others, Guy Harris was an important part of the very successful Dow Chemical group based in Martinez and Walnut Creek, CA, that developed a broad variety of flotation collectors and frothers, testing them in the laboratory and then shepherding them through commercial development. Dr. Harris was directly in charge of that part of the effort involved in the identification and synthesis of these reagents and cooperated with others in the development stage. Some years ago, as a consultant for Amax, I had considerable interaction with that Dow Chemical group and in particular with Guy Harris who had synthesized a sulfur-bearing polymer that enhanced the recovery of molybdenite in the Climax ore. Adding the sulfur atom to the molecule was Harris' idea.

A program of reagent development was initiated at Dow Midland under the general direction of the late Dr. R. R. Klimpel at about the time of Guy Harris' retirement in California. The background laid by Guy Harris was the underlying basis for the various reagents that Klimpel's group developed and promoted widely.

After he retired from Dow, Dr. Harris spent several months at Pennsylvania State University in the Mineral Processing Section working with Professor Frank Aplan and Dr. Klimpel (who also held the position of Adjunct Professor at Penn State) on a comprehensive program concerned with the role of chemical structure on the efficacy of collectors for the flotation of copper sulfide minerals and pyrite. After initial studies directed towards determining how altering the structure of the hydrocarbon chain on various standard collectors affected flotation effectiveness, they turned their attention to delineating how altering the molecular structure of the complex thionocarbamate molecule might regulate its effectiveness as a flotation collector. For this, a great deal of innovativeness was necessary in preparing a wide range of molecular configurations of thionocarbamates where molecular substitutions might alter adsorption and flotation performance by substituting various groups that control the steric assessability and the activity of the reactive N-C-S group (which binds the collector to the mineral surface). Their investigation involved determining how the addition and location of hydrocarbon groups (alkyl, branched chains, aryl) on the molecule affect the reactivity of the reagent. They further investigated how the introduction of a sulfur atom, or an oxygen atom, or a nitrogen atom at various locations on the molecule would affect such parameters as reagent solubility, oxidation, decomposition and solubility as well as its more important role in determining flotation selectivity, flotation rates and recovery. Guy Harris not only had significant input in suggesting how these substitutions influence steric assessability, electron density and hydrophobicity of the collector

compounds, but also worked out methods for their synthesis if the reagents were not already available. The results of that program are available to serve as a guide to others in sulfide reagent design.

In 1988 in the University of California at Berkeley, we were awarded a contract to investigate the desulfurization of high-sulfur coals by advanced flotation. At that time, Dr. Harris joined the research team as a Visiting Research Engineer. He was involved with devising standard flotation procedures by which we would make comparisons of the response on new flotation procedures and, more specifically, with the development of pyrite depressants. He suggested and synthesized a number of different pyrite depressants that had showed some success, but were limited by the degree of liberation of the coal and pyrite (since the Department of Energy specified the degree to which the coal could be ground). Subsequent work led to the design of some new depressants that show very significant potential in mineral flotation. His approach to depressant design was based on bifunctional molecules, which would have a group that interacts with the pyrite surface and also have hydrophilic groups that prevents bubble attachment.

Dr. Harris continues to come into the University about a day each week, working with graduate students. During these latter years, he became interested in developing a universal collector for the flotation of coal of various ranks and state of oxidation. He sought a bifunctional class of compounds (a series of hydrofurfural esters) that would have an oxygen-containing group that could hydrogen bond with the oxygenated surface sites on the coal and a hydrocarbon chain that could attach through hydrophobic bonding with hydrophobic carbonaceous sites on the coal. Thus, depending on the rank of the coal and its degree of oxidation, one or the other of these interaction mechanisms might be more dominant in effecting coal flotation. These have worked as successful collectors on a variety of coals, including those that had been oxidized in the laboratory. Planning what kind of molecule might have certain characteristics as a flotation reagent and working with graduate students to develop the reagent has been a real interest of Dr. Harris during the past few years. I am always impressed that he considers what the cost of producing such a reagent might be -- he aims at economic realism. No doubt his decades at Dow Chemical Company dictated that flotation reagents must have a realistic price.

I would like to point out the special fact that Guy Harris took a leave of absence from Dow for two years, 1962 -1964) to teach chemistry as a Senior Lecturer at the University of Ghana. While others talk about all the good things they would like to do for others, Guy Harris put his idea to help others who were less fortunate into actual practice. Several of the students that he had in his chemistry classes in Ghana went on to complete Ph.D. degrees in other universities around the world.

A wide range of individuals in the mineral industry world, both academic and industrial, have written in support of the nomination of Guy Harris for the Aplan Award.

Frank Aplan himself writes:

"It is my pleasure to endorse Dr. Guy H. Harris for the Aplan Award of AIME....In my view he would be an outstanding selection for this award....Guy is an old-line organic chemist with a memory bank of organic chemistry, synthesis procedures and flotation reagents that would put most people to shame....His greatest success was the development of Z-200 sulfide flotation collection which proved to be outstandingly successful on a world-wide basis."

Dr. Peter Avotins, recently retired as Manager of the Chemical Research Division, American Cyanamid Company (Cytec Industries), states strongly in his support Dr. Harris:

"There is no question that Dr. Harris has made significant contributions in the invention and development of flotation reagents. Perhaps I should put it stronger. He is a giant in our field and we owe him a great deal for the development of thionocarbamate chemistry for flotation collectors...I admire Guy Harris as a man of great integrity and professionalism."

Dr. D. R. Nagaraj, Associate Research Fellow, Cytec Industries, and an outstanding contributor to new flotation reagent development, enthusiastically endorses Dr. Harris:

"You have given me a very delightful and easy task of writing a letter of support in favor of Dr. Guy Harris for the distinguished Frank Aplan Award.....Easy task, because, having myself been involved in flotation research and development for over 25 years, I have an intimate knowledge of Dr. Harris' monumental contributions in this area and am qualified to evaluate it. Undoubtedly, Dr. Harris has been the preeminent researcher and inventor in the world [of flotation reagents] for almost half a century."

Dr. Brij Moudgil, Professor of Materials Science and Engineering and Director of Engineering Research Center for Particle Science and Technology at the University of Florida, writes:

"Guy Harris' approach for reagent design although based on chemistry fundamentals, has always been rooted in economic reality. This has been the cornerstone of his reagent design strategy when he was conducting research at Dow, or teaching students....His dedicated commitment to sharing his knowledge with the younger generation of chemists and mineral processing engineers is exceptional...I enthusiastically support his nomination for the prestigious Frank F. Aplan Award of AIME."

In his support of Dr. Harris' nomination for the Aplan Award, Dr. Roe-Hoan Yoon, Nicholas T. Camicia Professor at VPI, who has had many years of experience in investigating collector interactions with sulfide minerals, writes:

"It was certainly revolutionary thinking, at the time of his invention of Z-200, to use a neutral but highly reactive collector for sulfide mineral flotation."

Dr. S. Chander, Professor of Mineral Processing at Penn State, an expert in sulfide mineral surface chemistry and flotation comments:

"His invention of Z-200 is undoubtedly the most significant contribution to industrial progress in sulfide mineral flotation....I have indeed met him in several technical meetings and can describe him to be an example of a wonderful gentlemen. It is amazing that his love of science has continued long after his retirement from Dow in 1982.... Recognition of Dr. Harris is overdue and it would be timely to bestow the Frank F. Aplan Award on him. I support his nomination with great enthusiasm and highest respect for him."

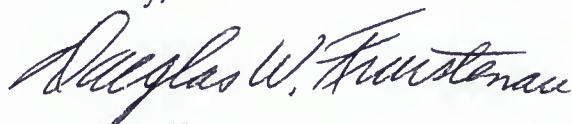
Professor Fiona Doyle of the University of California at Berkeley, who has had extensive contact with Dr. Harris in recent years, enthusiastically writes:

"Guy is a gifted organic chemist, with the highest standards of intellectual rigor, experimental skill, and scrupulous ethics. He is also a gifted mineral engineer, and extremely practical in his approach to problems. Although he knows how to synthesize almost anything, he never gets carried away attempting to make exotic reagents that could never be economic, unstable or unsafe. He conveys this practical perspective to students....His proactive approach to reagent chemistry is unusual for anyone, and quite remarkable for someone of his age....He is an invaluable resource for discussing ideas."

Dr. Patrick M. Afenya, Associate Professor in Mineral Process Engineering at the Papua New Guinea University of Technology, writes that he was a student of Dr. Harris in Ghana and that Harris' inspiration led to two students going overseas for Ph.D. studies. Dr. Afenya went to the Royal School of Mines, Imperial College, London. Afenya has maintained contact with Dr. Harris over the years and writes warmly of his continued interaction with Guy Harris and his work.

Dr. Guy Harris has been a person of great achievement through his invention and development of flotation reagents. His development of Z-200 certainly ranks next to that of Keller's discovery of xanthates in 1923. In a career that now spans over 60 years, he continues to work actively in mineral reagent chemistry and in instilling graduate students with his approach to developing new reagents and in inspiring them to seek success in their endeavors. It is fitting that Guy Harris receive recognition that he so richly deserves. Thus, in the highest terms, I recommend that he be awarded the 2003 Frank F. Aplan Award.

Sincerely,



Douglas W. Fuerstenau
Professor in the Graduate School

Preprint from the 1985

BUREAU OF MINES MINERALS YEARBOOK

This publication is a chapter from the current Bureau of Mines Minerals Yearbook, comprising Volume I, Metals and Minerals; Volume II, Area Reports; Domestic; Volume III, Area Reports; International. The separate volumes of the Yearbook are sold by the Superintendent of Documents, Washington, D.C. 20402.

UNITED STATES DEPARTMENT OF THE INTERIOR • Donald Paul Hodel, Secretary

BUREAU OF MINES • Robert C. Horton, Director

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Table 19.—Froth flotation plants operating in 1985, by type of ore and State¹

Type of ore and State	Number
Anthracite coal: Pennsylvania	2
Barite:	
Georgia.....	1
Nevada.....	1
Total	2
Baghouse: California	1
Bituminous coal:	
Alabama.....	2
Colorado.....	1
Illinois.....	1
Kentucky.....	1
Michigan.....	6
Maryland.....	1
Missouri.....	1
Ohio.....	1
Pennsylvania.....	11
Utah.....	1
Virginia.....	12
West Virginia.....	28
Total	76
Borate: Nevada	1
Copper:	
Arizona.....	8
Idaho.....	2
Montana.....	2
New Mexico.....	2
Total	8
Copper-lead-zinc: Missouri	8
Copper-molybdenum:	
Arizona.....	6
Utah.....	1
Total	7

See footnote at end of table.

Table 19.—Froth flotation plants operating in 1985, by type of ore and State¹—Continued

Type of ore and State	Number
Copper-silver-iron: Tennessee	1
Feldspar-silica-quartz:	
Connecticut.....	1
Georgia.....	1
New Mexico.....	7
North Carolina.....	7
Total	10
Glass sand:	
California.....	2
Georgia.....	1
Louisiana.....	1
Michigan.....	2
Pennsylvania.....	1
Tennessee.....	1
Total	8
Gold: Nevada	1
Gold-silver:	
Idaho.....	1
Montana.....	1
Washington.....	1
Total	8
Iron:	
Michigan.....	2
Minnesota.....	1
Missouri.....	1
Total	4
Lead-zinc:	
Colorado.....	2
Idaho.....	2
Missouri.....	2
New York.....	1
Oregon.....	1
Total	9
Limestone-magnesian:	
Maryland.....	1
Nevada.....	1
Texas.....	1
Vermont.....	1
Total	4
Mercury: Nevada	1
Molybdenum:	
Colorado.....	2
Idaho.....	1
New Mexico.....	1
Total	4
Phosphate:	
Florida.....	20
North Carolina.....	1
Utah.....	1
Total	22
Potash:	
New Mexico.....	4
Utah.....	1
Total	5
Silver: Idaho	1
Silver-lead-zinc:	
Idaho.....	1
Utah.....	1
Total	2
Zinc:	
Alabama.....	1
California.....	1
Vermont.....	1
South Carolina.....	1
Tennessee.....	4
Grand total	179

¹Includes only those plants responding to, or estimated for, by the Bureau of Mines.

Table 20.—Flotation mill production and consumption in 1985

Plant	Type	Number	Capacity (thousand short tons)	Ore treated (thousand short tons)	Energy used (kilowatt-hours)		Water used ¹ (gallons)		Rod consumption (pounds)		Ball consumption (pounds)		Steel liner consumption ² (pounds per ton)	Flotation concentrates produced ³ (thousand short tons)
					Total (millions)	Per ton	Total (millions)	Per ton	Total (thousands)	Per ton ²	Total (thousands)	Per ton ²		
Anthracite coal	2	W	W	W	W	W	W	W	W	W	W	W	W	W
Barite	2	W	W	W	W	W	W	W	W	W	W	W	W	W
Bastnaesite	1	W	W	W	W	W	W	W	W	W	W	W	W	W
Bituminous coal	75	36,114	27,666	899	6.6	88,886	326	W	W	W	W	W	W	19,506
Borate	1	W	W	W	W	W	W	W	W	W	W	W	W	W
Copper	8	56,185	68,816	1,051	16.8	47,687	693	7,402	0.885	90,015	1.308	0.092	2,771	W
Copper-lead-zinc	3	W	W	W	W	W	W	W	W	W	W	W	W	W
Copper-molybdenum	7	155,966	125,766	1,664	13.2	49,466	353	11,206	.556	133,718	1.063	.161	3,070	W
Copper-zinc-iron	1	W	W	W	W	W	W	W	W	W	W	W	W	W
Feldspar-mica-quartz	10	2,920	2,084	83	44.6	10,356	4,429	2,709	1.169	180	.257	.200	1,399	W
Glass sand	8	4,467	2,774	NA	NA	5,593	1,464	841	.324	265	1.104	W	2,878	W
Gold	1	W	W	W	W	W	W	W	W	W	W	W	W	W
Gold-silver	3	180	130	1	66	38	560	W	W	W	W	W	W	W
Iron	4	89,989	24,206	2,045	40.1	210,370	8,965	7,179	.669	9,853	2.202	.063	5	W
Lead-zinc	9	4,824	3,580	63	17.7	1,860	520	258	.090	1,792	.511	.054	18,428	W
Limestone-magnesite	4	W	194	NA	NA	224	555	66	.331	91	.923	W	740	W
Mercury	1	W	W	W	W	W	W	W	W	W	W	W	W	W
Molybdenum	4	36,923	24,064	256	16.0	7,066	294	W	W	W	W	W	W	W
Phosphate	22	160,087	120,687	1,849	11.3	565,852	3,164	304	.008	27,701	1.736	.221	27,681	W
Potash	5	16,860	11,100	121	10.9	793	71	4	.001	540	.491	.010	1,658	W
Silver	1	W	W	W	W	W	W	W	W	W	W	W	W	W
Talc	1	W	W	W	W	W	W	W	W	W	W	W	W	W
Tungsten	1	W	W	W	W	W	W	W	W	W	W	W	W	W
Vermiculite	1	W	W	W	W	W	W	W	W	W	W	W	W	W
Zinc	4	6,955	3,810	34	13.4	1,233	681	212	.214	545	.132	.010	166	W
Total	179	540,363	422,562	7,758	XX	947,356	XX	31,167	XX	269,154	XX	XX	80,100	XX

NA Not available. W Withheld to avoid disclosing company proprietary data; included in "Total." XX Not applicable.

¹Includes new or makeup and reclaimed water.

²Weighted average only for company reporting this data.

³Excludes concentrates produced by other physical separation methods.

Table 21.—Consumption of reagents at flotation plants in 1985, by ore type

(Thousand pounds)

Type of ore	Flotation reagents							Effluent treatment		
	Collectors	De-pressants	Activators	pH regulators	Frothers	Flocculants	Dispersants	pH regulators	Flocculants	Filtering aids
Sulfides:										
Copper	2,231	6	W	224,268	2,901	458	W	W	1,432	74
Copper-lead-zinc	W	W	W	W	W	W	W	W	W	W
Copper-molybdenum	6,347	25,329	14,618	369,396	4,747	548	325	352	262	716
Copper-zinc-iron	W	W	W	W	W	W	W	W	W	W
Gold	W	W	W	W	W	W	W	W	W	W
Gold-silver	4	W	W	94	1	W	W	W	W	W
Lead-zinc	441	694	684	882	217	2	W	2,876	102	246
Mercury	28	W	W	W	18	W	W	W	W	W
Molybdenum	12,661	1,046	W	9,500	1,841	W	32	W	W	W
Silver	W	W	W	W	W	W	W	W	W	W
Zinc	187	W	1,371	W	118	49	W	W	W	W
Total ¹	22,283	29,426	17,836	621,467	9,811	1,190	856	6,295	1,804	1,176
Metallic carbonates and oxides:										
Iron	6,695	83,688	76	61,295	408	1,271	2,439	20,830	18,312	5,231
Limestone-magnesite	648	159	W	6	25	76	W	569	5	W
Tungsten	173	W	W	177	W	W	W	W	142	W
Total ¹	6,516	83,798	76	61,477	433	1,347	3,280	20,898	18,460	6,231
Industrial minerals:										
Barite	W	W	W	W	W	W	W	W	W	W
Bastnaesite	W	W	W	W	W	W	W	W	W	W
Borate	W	W	W	W	W	W	W	W	W	W
Feldspar-mica-quartz	2,758	560	599	2,540	165	384	W	2,017	99	W
Glass sand	3,469	20	36	3,807	22	W	844	210	20	W
Phosphate	827,065	2,114	W	168,876	145	19	126	8,440	1,656	W
Potash	3,874	1,782	W	156	772	487	W	W	W	W
Talc	W	W	W	W	W	W	W	W	W	W
Vermiculite	W	W	W	W	W	W	W	W	W	W
Total ¹	339,601	4,696	636	177,287	1,150	1,137	491	10,684	1,777	W
Anthracite and bituminous coal	5,913	W	W	779	3,748	2,811	W	1,023	1,823	1,547
Grand total	874,312	67,819	18,547	860,982	14,941	6,485	4,128	87,900	23,863	8,054

W Withheld to avoid disclosing respondent proprietary data; included in "Total" and "Grand total."

¹Date may not add to totals shown because of independent rounding.

MINING AND QUARRYING TRENDS

[illegible]

FLUTATION REAGENTS—Continued

Problems—Continued		
Polyethyl ether	1,679	.029
Unspecified poly	2,444	.032
Petroleum-based blends	2,926	.1516
Total pounds	14,941	
Value	\$8,817,894	
Flocculants:		
Aluminum salts	819	
Cationic polyacrylamide	1,754	.144
Cationic polyacrylamide	166	.007
Nonionic polyacrylamide	224	.022
Unspecified polyacrylamide	197	.006
Polyacrylates	439	.027
Polyacrylonitrile	21	.012
Polyethylene oxides	21	.001
Unspecified polymer	2,879	.299
Total pounds	6,485	
Value	\$5,166,789	
Activators:		
Copper salt	3,159	.298
Sodium sulfide or hydrosulfide	14,678	.662
Hydrofluoric acid	699	.813
Sodium hydroxide	38	.790
Other	78	.023
Total pounds	19,647	
Value	\$8,171,890	

**Sodium silicate,
Polysilicate**

EFFLUENT TREATMENT REAGENTS	
Total reagents:	4.198
Pounds	\$1,060.455
Value	1,347.316
	\$150,263.042
pH regulator:	
Sulfuric acid (H ₂ SO ₄)	9.879
Sulfuric acid (NaOH)	1.738
Line	26,524
	1,817

	Value	Total polymer value
Fluocyclant:		
Aluminum salts	7,436	
Silicate-cellulose	1	
Acrylic polymers	2,755	
Carbonic polyacrylamide	863	
Nonionic polyacrylamide	9	
Unspecified polyacrylamide	874	
Polyacrylate		
Polyamide	62	
Polyethyleneimide	5	
Polyethyleneimide	11	
Unspecified polymer	11,739	
	161	
	418	37,900
	1,081	\$2,244,760

Total number

Table 22.—Consumption, value, and function at flotation plants in 1985—Continued

Function and name	Consumption	
	Total (thousand pounds)	Pounds per ton
OTHER REAGENTS		
Nonionic surfactants	6,391	199
Polyacrylamides	38	122
Polymers	8,346	216
Unspecified polymer	182	270
Total pounds ¹	8,964	
Value	\$5,670,295	
Grinding aids:		
Sodium hexametaphosphate	7	590
Total pounds	7	
Value	\$4,080	

¹Data may not add to totals shown because of independent rounding.

Table 23.—Froth flotation of sulfide ores

	1960	1965	1970	1975	1980	1985
Operational data:						
Number of plants	35	108	105	86	71	42
Capacity of plants: thousand short tons						
On treated	191,100	217,700	301,700	346,600	354,400	278,715
Concentrates produced	156,100	200,800	281,700	276,500	279,500	233,100
Concentration factor	5,855	7,218	8,853	7,595	7,565	8,178
Reagent consumption:						
Collectors—thousand pounds	25,346	28,988	32,185	27,972	38,704	22,228
Depressants	6,338	10,868	17,061	33,418	51,433	22,428
Activators	7,859	8,983	8,488	11,338	7,530	17,836
Modifier: ²						
pH regulators in flotation	NA	NA	NA	NA	NA	621,467
pH regulators in effluent treatment	NA	NA	NA	NA	NA	6,236
Dispersants in flotation	NA	NA	NA	NA	NA	856
Dispersants in effluent treatment	NA	NA	NA	NA	NA	
Total	489,707	765,677	1,198,713	1,107,455	864,791	627,198
Frothers	12,411	18,502	20,612	18,814	17,717	9,611
Flocculants: ³						
In flotation	1,129	651	2,624	4,708	1,984	1,150
In effluent treatment	NA	NA	NA	NA	NA	1,804
Total	1,129	651	2,624	4,708	1,984	2,994
Other reagent: filtering aid	NA	NA	NA	NA	NA	3,176

NA Not available.
¹Annual capacity for 1960-80 calculated from daily capacity assuming 850 operating days per year.
²Only the totals are available for historical data, which excludes effluent treatment.

Table 24.—Froth flotation of metallic carbonate and oxide ores

	1960	1965	1970	1975	1980	1985
Operational data:						
Number of plants	13	14	13	13	13	9
Capacity of plants: thousand short tons						
On treated	4,900	6,800	22,750	31,500	32,850	24,080
Concentrates produced	2,854	16,079	22,213	30,149	42,903	24,490
Concentration factor	341	7,086	13,040	16,582	24,045	19,670
Reagent consumption:						
Collectors—thousand pounds	3.0	2.3	1.7	1.9	1.8	1.7
Depressants	22,573	23,695	31,819	22,301	18,467	6,516
Activators	610	1,588	2,687	18,226	30,585	38,798
Modifier: ²						
pH regulators in flotation	NA	NA	NA	NA	NA	61,477
pH regulators in effluent treatment	NA	NA	NA	NA	NA	20,808
Dispersants in flotation	NA	NA	NA	NA	NA	3,280
Dispersants in effluent treatment	NA	NA	NA	NA	NA	
Total	6,539	16,290	81,635	39,457	79,063	85,655
Frothers	1,343	865	164	387	908	433
Flocculants: ³						
In flotation	1,906	458	220	1,985	79,136	1,347
In effluent treatment	NA	NA	NA	NA	NA	18,460
Total	1,906	458	220	1,985	79,136	19,807
Other reagents: ⁴						
Filtering aid	NA	NA	NA	NA	NA	6,231
Grinding aid	NA	NA	NA	NA	NA	

NA Not available.
¹Annual capacity for 1960-80 calculated from daily capacity assuming 350 operating days per year.
²Only the totals are available for historical data, which excludes effluent treatment.

Table 25.—Froth flotation of industrial mineral ores

	1960	1965	1970	1975	1980	1985
Operational data:						
Number of plants	55	64	56	75	76	51
Capacity of plants: thousand short tons						
On treated	50,400	65,650	182,300	163,650	186,400	134,313
Concentrates produced	36,137	62,655	80,863	100,359	118,550	137,351
Concentration factor	11,888	17,976	22,522	29,111	42,812	32,711
Reagent consumption:						
Collectors—thousand pounds	3.0	3.0	3.4	3.8	3.5	4.2
Depressants	163,867	188,119	623,659	345,208	431,742	339,692
Activators	9,231	4,346	11,023	7,314	11,712	4,885
Modifier: ²						
pH regulators in flotation	NA	NA	NA	NA	NA	177,267
pH regulators in effluent treatment	NA	NA	NA	NA	NA	10,884
Dispersants in flotation	NA	NA	NA	NA	NA	391
Dispersants in effluent treatment	NA	NA	NA	NA	NA	
Total	82,455	54,889	161,470	112,639	116,819	191,124
Frothers	2,719	4,870	2,688	4,740	6,508	1,150
Flocculants: ³						
In flotation	875	8,207	761	2,477	2,914	1,157
In effluent treatment	NA	NA	NA	NA	NA	1,777
Total	875	8,207	761	2,477	2,914	2,914

NA Not available.
¹Annual capacity for 1960-80 calculated from daily capacity assuming 350 operating days per year.
²Only the totals are available for historical data, which excludes effluent treatment.

Table 26.—Froth flotation of anthracite and bituminous coal

	1960	1965	1970	1976	1980	1985
Operational data:						
Number of plants	31	69	66	78	80	77
Capacity of plants— thousand short tons—	6,160	11,760	15,600	16,075	18,776	38,278
Raw coal treated— do—	4,112	9,500	13,006	13,079	12,901	27,720
Coal not produced— do—	2,796	7,083	8,418	8,779	7,587	19,540
Concentrate— thousand pounds—	8,142	4,065	7,772	4,815	4,917	6,918
Modified:						
At treatment in flotation	1,609	298	2,716	298	26	779
At treatment in effluent	NA	NA	NA	NA	NA	1,022
Total	1,609	298	2,716	298	26	779
Frothers	585	1,555	2,564	2,568	3,044	3,748
Flocculants:						
In flotation treatment	394	2,301	2,204	1,308	3,521	2,811
In effluent treatment	NA	NA	NA	NA	NA	1,835
Total	394	2,301	2,204	1,308	3,521	4,646
Other reagents, floating aid, do.	NA	NA	NA	NA	NA	1,647

NA Not available.
Annual capacity for 1960-80 calculated from daily capacity assuming 250 operating days per year.
Effluent treatment not available for historical data.

Table 27.—Froth flotation of copper in 1985

OPERATING DATA									
Plant:	Number	8	Energy used, kilowatt-hours:	Total	1,051	Per ton	16.3		
Design capacity— thousand short tons—	66,135		Rod consumption, pounds:	Total	7,402	Per ton	0.385		
One treated:	Quantity	69,816	Per ton	0.385					
Grades:	Percent	0.35	Ball consumption, pounds:	Total	90,015	Per ton	1.308		
Copper	0.001	0.001	Per ton	0.002					
Silver	0.002	0.002	Steel total	47,687					
Water used, gallons:	do.	47,687	Per ton	0.002					
New or makeup	do.	12,927	Per ton	0.002					
Reclaimed	do.	35,050	Per ton	0.004					
Per ton	0.004								
CONCENTRATES PRODUCED									
Type	Quantity (thousand short tons)	Grade (percent)	Recovery (percent)	Type	Grade (percent)	Recovery (percent)	Quantity (thousand pounds)	Value (thousands)	Per ton
Copper	1,553	25.02	79	Silver	11.277	0.013	88	49	
REAGENT CONSUMPTION									
Function and type	Quantity (thousand pounds)	Value (thousands)	Quantity (pounds)	Value					
Froth reagents:									
Collector:									
Amylxanthate	397	\$354	0.028	\$0.015					
Isopropylxanthate	397	194	0.025	0.016					
Allyl diethyldithiocarbamate	186	104	0.005	0.003					
Thiocarbamate	148	846	0.015	0.018					
Mixture of alkyl reagents	475	475	0.011	0.016					
Unspecified alkyl reagents	338	338	0.008	0.002					
Total	2,232	2,232	0.064	\$0.043					
Depressant: Cysteine salt	6	1,891	0.014	0.012					
pH regulator: Lime	224,288	10,667	9,997	155					

See footnotes at end of table.

Table 27.—Froth flotation of copper in 1985—Continued

OPERATING DATA									
Plant:	Number	7	Energy used, kilowatt-hours:	Total	1,654	Per ton	18.2		
Design capacity— thousand short tons—	166,966		Rod consumption, pounds:	Total	11,206	Per ton	0.556		
One treated:	Quantity	125,766	Per ton	0.556					
Grades:	Percent	0.64	Ball consumption, pounds:	Total	138,718	Per ton	1.068		
Copper	0.006	0.006	Per ton	0.002					
Molybdenum	0.002	0.002	Steel total	49,465					
Gold	0.002	0.002	Per ton	0.002					
Silver	0.002	0.002	Per ton	0.002					
Water used, gallons:	do.	49,465	Per ton	0.002					
New or makeup	do.	20,728	Per ton	0.002					
Reclaimed	do.	28,736	Per ton	0.002					
Per ton	0.002								
CONCENTRATES PRODUCED									
Type	Quantity (thousand short tons)	Grade (percent)	Recovery (percent)	Type	Grade (percent)	Recovery (percent)	Quantity (thousand pounds)	Value (thousands)	Per ton
Copper	2,052	27.46	83	Gold	0.064	0.004	82	81	
Molybdenum	32	48.64	25	Silver	1.467	0.006	81	81	
REAGENT CONSUMPTION									
Function and type	Quantity (thousand pounds)	Value (thousands)	Quantity (pounds)	Value					
Froth reagents:									
Collector:									
Amylxanthate	417	\$250	0.022	\$0.013					
Isopropylxanthate	261	167	0.007	0.004					
Allyl diethyldithiocarbamate	128	84	0.004	0.004					
Unspecified xanthates	224	388	0.006	0.010					

See footnotes at end of table.

Table 28.—Froth flotation of copper-molybdenum in 1985—Continued

Function and type	Total			Per ton		
	Quantity (thousands pounds)	Value (thousands)	Quantity (pounds)	Value		
Flotation reagents—Continued						
Collectors—Continued						
All-yl diethylenephosphate	405	3382	.021	\$0.018		
Unsaturated polyacrylamide	62	93	.003	.085		
Xanthogenic formate	48	80	.006	.010		
Thionocarbamate	109	1,426	.018	.087		
Unsaturated sulfide collector	769	550	.028	.020		
Fuel oil	2,267	442	.037	.007		
Kerosene	35	10	.003	.001		
Total	6,346	3,902	XX	XX		
Depressants						
Diisopropyl pentafluoride	1,926	673	1.068	.318		
Cyanide salt	3,662	1,543	2.684	.287		
Sulfide salt	19,549	3,587	6.874	1.235		
Sodium silicate	102	20	1.720	.244		
Total	26,329	6,723	XX	XX		
Activators: Sodium sulfide or hydrosulfide	14,613	6,676	.677	.306		
pH regulators						
Sulfuric acid	2,283	7	7.040	.021		
Caustic soda (NaOH)	3	1	.057	.020		
Total	387,129	12,158	2,839	.09		
Total	389,386	12,168	XX	XX		
Products						
Aliphatic alcohol	2,986	1,532	.061	.02		
Pine oil	227	77	.012	.004		
Phenol	219	806	.036	.023		
Polypropyl ether	587	232	.006	.004		
Unspecified polyol	587	232	.021	.008		
Total	4,746	2,773	XX	XX		
Fluoculants						
Anionic polyacrylamide	167	110	.006	.004		
Nonionic polyacrylamide	62	122	.007	.007		
Polyacrylic acid	874	250	.010	.009		
Unspecified polymer	66	58	.118	.099		
Total	649	540	XX	XX		
Dispersants						
Sodium silicate	51	10	.160	.032		
Polyphosphate	273	169	.016	.010		
Total	324	179	XX	XX		
Effluent treatment: pH regulators: Sulfuric acid	362	179	1.056	.003		
Fluoculants						
Anionic polyacrylamide	6	13	.020	.048		
Nonionic polyacrylamide	211	133	.011	.009		
Unspecified polymer	46	34	.002	.002		
Total	258	220	XX	XX		
Filtering aids						
Nonionic surfactants	701	513	.700	.612		
Unspecified polymer	16	8	.255	.185		
Total	716	521	XX	XX		

XX Not applicable.
These values are for the flotation section only and would exclude material processed by other separation methods.
Other operating data are for the entire plant (grinding mill and concentrator).
Weighted average only for respondents reporting this data.

Table 29.—Froth flotation of lead-zinc in 1985

OPERATING DATA									
Plant:		Energy used, kilowatt-hours:		Byproducts					
Number	9	Total	millions	Grade	Quantity	Recovery	Quantity	Recovery	
Design capacity	4,824	Per ton	17.7	Grade	Quantity	Recovery	Quantity	Recovery	
One created:		Feed consumption, pounds:		or type	Quantity	Recovery	Quantity	Recovery	
Quantity		Total	thousands		Quantity	Recovery	Quantity	Recovery	
Grade		Per ton	258		Quantity	Recovery	Quantity	Recovery	
Lead	percent	Ball consumption, pounds:			Quantity	Recovery	Quantity	Recovery	
Silver	percent	Total	thousands		Quantity	Recovery	Quantity	Recovery	
Gold	percent	Per ton	1,782		Quantity	Recovery	Quantity	Recovery	
Zinc	percent	Linear consumption, pounds:			Quantity	Recovery	Quantity	Recovery	
Waste used, gallons:	millions	Steel total	thousands		Quantity	Recovery	Quantity	Recovery	
Total	do	Per ton	4,864		Quantity	Recovery	Quantity	Recovery	
Water used, gallons:	do	Rubber total	thousands		Quantity	Recovery	Quantity	Recovery	
Total	do	Per ton	17		Quantity	Recovery	Quantity	Recovery	
Per ton	do	Per ton	0.170		Quantity	Recovery	Quantity	Recovery	
CONCENTRATES PRODUCED									
Type		Quantity		Grade					
		(thousands short tons)		(percent)					
Lead	271	74.21	96	Silver	20,706	73			
				Zinc	5,138	4			
				Gold	1,085	73			
				Copper	1,300	62			
Zinc	183	56.28	90	Silver	2,380	10			
				Lead	9,765	8			
				Copper	1,200	18			
REAGENT CONSUMPTION									
Function and type		Quantity		Value					
		(thousands pounds)		(thousands)					
Flotation reagents:									
Collectors									
Amylanthate	123	\$95	0.187	\$0.107					
Amylanthate	8	7	.000	.001					
Amylanthate	219	188	.082	.067					
Amylanthate	47	39	.080	.067					
Amylanthate	17	27	.046	.030					
Thionocarbamate	29	20	.080	.062					
Unspecified sulfide collector									
Total	442	381	XX	XX					
Depressants:									
Cyanide salt	66	73	.027	.028					
Zinc sulfide	697	180	.215	.064					
Total	668	253	XX	XX					
Activators:									
Copper salt	824	870	.186	.110					
Sodium sulfide or hydrosulfide	60	16	.102	.028					
Total	684	886	XX	XX					
pH regulators:									
Sulfuric acid	984	36	.387	.014					
Total	47	6	.001	.001					
Fluoculants:									
Anionic polyacrylamide	881	40	XX	XX					
Nonionic polyacrylamide									
Unspecified polymer									
Total	217	134	XX	XX					
Products:									
Aliphatic alcohol	189	119	.056	.085					
Polypropyl ether	17	14	.020	.176					
Petroleum-based blends	1	1							
Total	217	134	XX	XX					
Fluoculants:									
Anionic polyacrylamide	1	1	.100	.102					
Nonionic polyacrylamide									
Unspecified polymer									
Total	2	4	XX	XX					

See footnotes at end of table.

Table 29.—Froth flotation of lead-zinc in 1985—Continued

Function and type	Total		Per ton	
	Quantity (thousand pounds)	Value (thousands)	Quantity (pounds)	Value
Effluent treatment				
pH regulators				
Sulfuric acid	108	\$3	.500	\$0.016
Lime	2,767	106	2,582	.089
Total	2,875	109	XX	XX
Frocculants				
Anionic polyacrylamide	101	78	.515	.242
Unspecified polyacrylamide	1	2	.009	.025
Total	102	80	XX	XX
Filtering aids				
Nonionic surfactants	246	130	.108	.067
Polyacrylamides			.001	.001
Total	246	130	XX	XX

XX Not applicable.
These values are for the flotation section only and would exclude material processed by other separation methods.
Other operating data are for the entire plant (grinding mill and concentrator).
*Weighted average only for respondents reporting this data.

Table 30.—Froth flotation of molybdenum in 1985

OPERATING DATA				
Plant:				
Number	4	Energy used, kilowatt-hours:		
Design capacity ¹ —thousand short tons	36,923	Total	millions	265
Ore treated ¹		Per ton		16.0
Quantity	24,064	Ball consumption, pounds:		
Grade: Molybdenum		Total	thousands	27,701
—percent	0.20	Per ton ²		1,786
Water used, gallons:		Steel liner consumption, pounds:		
Total	7,066	Total	thousands	5,320
New or makeup	2,847	Per ton ²		0.221
Recycled	4,219			
Per ton	294			
CONCENTRATES PRODUCED				
Type		Quantity (thousand short tons)	Grade (percent)	Recovery (percent)
Molybdenum		67	61.73	85
REAGENT CONSUMPTION				
Function and type		Quantity (thousand pounds)	Value (thousands)	Per ton Quantity (pounds)
Total				Value
Flotation reagents:				
Collectors				
Petrobrium derivative	9,397	\$6,467	.811	.730
Fuel oil	2,884	819	.228	.026
Other	610	73	.140	.017
Total	12,891	\$7,349	XX	XX
Depressants:				
Phosphonium pentaurifide	890	450	.068	.085
Sulfuric acid	15	13	.060	.001
Sulfate	41	5	.006	.001
Unspecified depressant	101	106	.023	.024
Total	1,047	576	XX	XX

See footnotes at end of table.

Table 30.—Froth flotation of molybdenum in 1985—Continued

Function and type	Total		Per ton	
	Quantity (thousand pounds)	Value (thousands)	Quantity (pounds)	Value
Flotation reagents—Continued				
pH regulators				
Sulfuric acid	1,500	\$135	.270	\$0.024
Lime	8,000	367	.448	.020
Total	9,500	502	XX	XX
Frothers:				
Aliphatic alcohol	553	\$14	.045	.025
Pine oil	488	190	.048	.033
Polypropyl ether	210	193	.086	.097
Unspecified polyol	60	32	.019	
Total	1,341	729	XX	XX
Depressants: Sodium allicata	32	6	.616	.103

XX Not applicable.
These values are for the flotation section only and would exclude material processed by other separation methods.
Other operating data are for the entire plant (grinding mill and concentrator).
*Weighted average only for respondents reporting this data.

Table 31.—Froth flotation of zinc in 1985

OPERATING DATA				
Plant:				
Number	4	Energy used, kilowatt-hours:		
Design capacity ¹ —thousand short tons	6,655	Total	millions	34
Ore treated ¹		Per ton		13.4
Quantity	3,310	Rod consumption, pounds:		
Grade: Zinc		Total	thousands	212
—percent	3.8	Per ton ²		0.216
Water used, gallons:		Ball consumption, pounds:		
Total	1,233	Total	thousands	545
New or makeup	77	Per ton ²		0.182
Recycled	1,156	Steel liner consumption, pounds:		
Per ton	381	Total	thousands	6
		Per ton ²		0.010
CONCENTRATES PRODUCED				
Type		Quantity (thousand short tons)	Grade (percent)	Recovery (percent)
Zinc		135	63.52	95
REAGENT CONSUMPTION				
Function and type		Quantity (thousand pounds)	Value (thousands)	Per ton Quantity (pounds)
Total				Value
Flotation reagents:				
Collectors				
Allyl diethyldithiocarbamate	3	\$3	0.004	\$0.004
Allyl diethyldithiocarbamate	126	105	.047	.089
Mecroprobenzothiazole	38	35	.070	.063
Total	167	143	XX	XX
Activators: Copper sulfate	1,371	509	.823	.228
Frothers: Polypropyl ether	118	99	.053	.117
Frocculants: Nonionic polyacrylamide	49	89	.066	

XX Not applicable.
These values are for the flotation section only and would exclude material processed by other separation methods. One plant (grinding mill and concentrator).
*Weighted average only for respondents reporting this data.

OPERATING DATA

NA not applicable.
These values are for the flotation section only and would exclude material processed by other separation methods.
Other operating data are for the entire plant (grinding mill and concentrator).
Weighted average only for respondents reporting this data.

OPERATING DATA

XX Not applicable
These values are for the Ignition section only and would exclude material processed by other separation methods.
Other operating data are for the entire plant (grinding mill and concentrator).
Any weighted average only for respondents reporting this data.
Less than 1/2 unit.

Table 34.—Froth flotation of feldspar-mica-quartz in 1985

OPERATING DATA					
Plant:	Number	Rod consumption, pounds:		Quantity (thousand short tons)	
		Total	Per ton	Total	Per ton
Design capacity ¹	10	2,920		1,169	
On line ²		2,920		1,169	
Water used, gallons:		Total		thousands	
		Total	Per ton	Total	Per ton
New or make-up	10,365			0.257	
Reclaimed	2,084			0.083	
Boiler/cooling water	4,429			0.109	
Boiler/cooling water	4,429			0.109	
Total	16,883			0.449	
Per ton	8			0.011	
CONCENTRATES PRODUCED					
Type	Quantity (thousand short tons)	Value (thousands)	Quantity (thousands)	Value (thousands)	Per ton
Quartz	258		258		
Feldspar	607		607		
Mica	67		67		
Lithium dioxide	W		W		
REAGENT CONSUMPTION					
Function and type	Quantity (thousand pounds)	Value (thousands)	Quantity (pounds)	Value	Per ton
Flotation reagents:					
Collector:	125	\$117	488	454	
Dihydroxyanthracene	287	282	383	292	
Fatty acid and soap	287	282	383	292	
Fatty acid derivative	1,000	350	1,600	525	
Petroleum sulfonates	251	107	877	373	
Fuel oil	210	183	234	148	
Total	2,769	1,065	XX	XX	
Depressant:	525	202	1,144	441	
Hydrofluoric acid	35	1	300	106	
Lignin derivative	590	203	XX	XX	
Total	625	203	XX	XX	
Activator:	599	271	813	368	
Hydrofluoric acid	1,743	66	1,543	648	
Sulfuric acid	797	91	598	268	
Caustic soda (NaOH)	2,540	147	XX	XX	
Problems:					
Aliphatic alcohol	40	21	101	655	
Pine oil	39	24	1,037	1,022	
Polyglycol	8	4	1,004	1,004	
Polyglycol ether	35	25	1,066	1,066	
Petroleum-based blends	48	24	384	287	
Total	170	105	XX	XX	
Flocculant:	561	10	140	104	
Aluminum salts	33	36	040	043	
Unspecified polymer	384	48	XX	XX	
Effluent treatment:					
pH regulators:	719	14	8,420	688	
Caustic soda (NaOH)	1,299	56	2,121	105	
Lime	2,018	69	XX	XX	

See footnotes at end of table.

Table 34.—Froth flotation of feldspar-mica-quartz in 1985—Continued

OPERATING DATA					
Function and type	Quantity (thousand pounds)	Value (thousands)	Quantity (pounds)	Value	Per ton
Effluent treatment—Continued					
Flocculant:	5	\$6	0.040	\$0.050	
Unspecified polyacrylamide	65	62	258	288	
Polyacrylate	11	9	800	698	
Polyethyleneimine	29	38	009	012	
Unspecified polymer	100	105	XX	XX	
W Withheld to avoid disclosing company proprietary data. XX Not applicable.					
These values are for the flotation section only and would exclude material processed by other separation methods.					
Other operating data are for the entire plant (grinding mill and concentrator).					
Weighted average only for respondents reporting this data.					
Table 35.—Froth flotation of glass sand in 1985					
OPERATING DATA					
Plant:	Number	Rod consumption, pounds:		Quantity (thousand short tons)	
		Total	Per ton	Total	Per ton
Design capacity ¹	8	4,467		0.324	
On line ²		2,774		0.324	
Water used, gallons:		Total		thousands	
		Total	Per ton	Total	Per ton
New or make-up	6,593			256	
Reclaimed	383			1.104	
Total	6,976			1.104	
Per ton	1,464			1.104	
CONCENTRATES PRODUCED					
Type	Quantity (thousand short tons)	Value (thousands)	Quantity (thousands)	Value	Per ton
Glass sand	2,279		2,279		
REAGENT CONSUMPTION					
Function and type	Quantity (thousand pounds)	Value (thousands)	Quantity (pounds)	Value	Per ton
Flotation reagents:					
Collector:	91	\$16	0.140	\$0.116	
Dihydroxyanthracene	2,633	812	1,118	863	
Fatty acid and soap	696	70	885	104	
Petroleum sulfonates	3469	993	XX	XX	
Total	36	8	730	068	
Depressant:	1,922	96	2,465	122	
Sulfuric acid	1,885	173	1,425	130	
Caustic soda (NaOH)	3,807	268	XX	XX	
Problems:					
Pine oil	4	2	007	004	
Polyglycol	16	13	150	129	
Petroleum-based blends	3	3	8,400	7,727	
Total	22	18	XX	XX	
Depressant:	344	24	3,440	227	
Sulfuric acid	210	7	563	018	
Caustic soda (NaOH)	20	17	1,150	978	
Unspecified polymer	XX	XX	XX	XX	

XX Not applicable.

These values are for the flotation section only and would exclude material processed by other separation methods.

Other operating data are for the entire plant (grinding mill and concentrator).

Weighted average only for respondents reporting this data.

Table 36.—Froth flotation of phosphate in 1985

OPERATING DATA					
Plant:	Energy used, kilowatt-hours:	millions			
Number	22	Total	Per ton	Recovery (percent)	1.849
Design capacity ¹ - thousand short tons	150,087	Total	Per ton	Recovery (percent)	11.3
Quantity	120,687	Total	Per ton	Recovery (percent)	804
Grade	9.94	Total	Per ton	Recovery (percent)	0.008
Water used, gallons:		thousands			
Total	865,862	Total	Per ton	Recovery (percent)	540
New or makeup	88,487	Total	Per ton	Recovery (percent)	0.491
Recycled	887,384	Total	Per ton	Recovery (percent)	
Per ton	8.164	Total	Per ton	Recovery (percent)	

CONCENTRATES PRODUCED					
Plant:	Quantity (thousand short tons)	Grade (percent)	Recovery (percent)		
P ₂ O ₅	27,081	81.21	70		

REAGENT CONSUMPTION					
Function and type	Quantity (thousand pounds)	Value (thousands)	Quantity (pounds)	Value	Per ton
Frothing reagents:					
Collectors:					
Sulfonyl amine	4,847	\$1,600	0.228	\$0.074	
Unsulfonated amine	4,800	2,880	1.200	720	
Amber derivative	6,885	2,444	221	131	
Quaternary ammonium salt	6,080	2,355	387	131	
Fatty acid and rosin acids and soaps	15,144	853	318	107	
Petroleum sulfonates	10,770	23,318	1,418	316	
Petroleum derivatives	110	1,359	102	102	
Fuel oil ²	676	68	7074	105	
Kerosene	180,943	12,521	1,268	171	
Total	276,410	47,860	XX	XX	
Depressants:					
Sodium silicate	1,740	139	150	015	
Starches, celluloses, derivatives	874	52	350	049	
Total	2,614	191	XX	XX	
pH regulators:					
Sulfuric acid	134,866	3,398	1,320	083	
Caustic soda (NaOH)	6,649	455	256	042	
Ammonia or ammonium hydroxide	28,962	2,626	294	027	
Total	168,877	6,479	XX	XX	
Foamers:					
Polyethyl ether	82	41	019	009	
Unspecified polyol	15	1	400	380	
Petroleum-based blends	50	32	200	128	
Total	146	84	XX	XX	
Flocculants:					
Anionic polyacrylamide	18	17	005	003	
Dispersants: Sodium silicate	126	19	008	001	
Effluent treatment					
Flocculant: Sulfuric acid	8,440	228	7,810	214	
Flocculant: Anionic polyacrylamide	1,655	2,188	742	361	

XX Not applicable.
¹These values are for the flotation section only and would exclude material processed by other separation methods.
²These values are for the entire plant (grinding mill and concentrator).
 Other operating data are for the entire plant (grinding mill and concentrator).
 Includes fuel oil used as an extender or activator.

Table 37.—Froth flotation of potash in 1985

OPERATING DATA					
Plant:	Water used, gallons:	millions			
Number	5	Total	New or makeup	Recovery (percent)	798
Design capacity ¹ - thousand short tons	16,850	Total	Recovery (percent)	514	
Quantity	11,100	Total	Recovery (percent)	71	
Grade K ₂ O	11.30	Total	Recovery (percent)	121	
Per ton		Total	Recovery (percent)	10.9	

CONCENTRATES PRODUCED					
Plant:	Quantity (thousand short tons)	Grade (percent)	Recovery (percent)		
K ₂ O	1,569	38.15	78		

REAGENT CONSUMPTION					
Function and type	Quantity (thousand pounds)	Value (thousands)	Quantity (pounds)	Value	Per ton
Frothing reagents:					
Collectors:					
Primary amine	676	\$454	0.136	\$0.098	
Quaternary ammonium salt	230	83	089	025	
Fatty acid and rosin acids and soaps	990	188	350	070	
Petroleum derivative	26	10	060	024	
Fuel oil	1,958	218	425	046	
Total	3,874	958	XX	XX	
Depressants:					
Gum and dextrans	1,752	332	208	040	
pH regulators: Hydrochloric acid	165	8	059	002	
Prothers:					
Aliphatic alcohol	525	294	054	030	
Polyethyl ether	1	1	002	002	
Petroleum-based blends	246	39	112	018	
Total	772	334	XX	XX	
Flocculants:					
Anionic polyacrylamide	48	42	006	007	
Unspecified polyol	17	31	009	015	
Unspecified polymer	424	215	182	097	
Total	487	288	XX	XX	

XX Not applicable.
¹These values are for the flotation section only and would exclude material processed by other separation methods.
 Other operating data are for the entire plant (grinding mill and concentrator).

Table 38.—Froth flotation of bituminous coal in 1985

OPERATING DATA				
Plant:	Water used, gallons	millions.	millions.	millions.
Number	75	Total	38,886	
Design capacity ¹ - thousand short tons	36,114	Net output	4,085	
Raw coal treated - do.	27,666	Recl. used	84,791	
Energy used, kilowatt-hours:		Per ton	328	
Total	899			
Per ton	6.5			
CONCENTRATES PRODUCED				
Type	Quantity (thousand short tons)	Value (thousands)	Quantity (thousands)	Value
Clean coal	13,509			
REAGENT CONSUMPTION				
Function and type	Quantity (thousand pounds)	Value (thousands)	Quantity (pounds)	Value
Total				
Flocculation reagents:				
Collectors:				
Fatty acid derivative	11	\$17	0.043	\$0.065
Petroleum derivative	306	249	.191	.155
Unspecified nonsulfide collectors	90	125	.057	.079
Unspecified sulfide collectors	13	8	.006	.009
Unspecified derivatives	6,082	3,025	.772	.222
Pyral oil	423	53	.742	.096
Kerosene				
Total	6,910	3,474	XX	XX
pH regulators:				
Cacetic soda (NaOH)	738	63	.526	.045
Lime	11	1	.014	.001
Ammonia or ammonium hydroxide	30	7	.640	.154
Total	778	71	XX	XX
Preharvest:				
Aliphatic alcohol	688	671	.127	.112
Aliphatic ester	3	5	.000	.002
Polyvinyl alcohol	906	674	.223	.173
Unspecified polyol	151	26	.008	.009
Petroleum-based blends	1,979	1,456	.174	.125
Total	3,742	2,842	XX	XX
Flocculant:				
Aluminum salts	12	2	.055	.007
Anionic polyacrylamide	1,274	1,726	.406	.533
Cationic polyacrylamide	166	87	.005	.013
Unspecified polyacrylamide	180	146	.003	.007
Polyacrylate	63	54	-	-
Polyacrylamide	486	243	2.499	1.250
Unspecified polymer	628	502	.304	.153
Total	2,809	2,760	XX	XX
Effluent treatment:				
pH regulators:				
Cacetic soda (NaOH)	1,015	128	3.040	.282
Lime	5	(7)	.019	.001
Total	1,024	128	XX	XX
Flocculant:				
Starch-cellulose	1	3	.004	.007
Anionic polyacrylamide	854	716	.066	.087
Cationic polyacrylamide	853	507	.275	.154
Unspecified polyacrylamide	9	5	.195	.107
Polyacrylate	86	46	.127	.104
Polyacrylamide	17	17	.250	.111
Unspecified polymer	24	24	.160	.106
Total	1,823	1,318	XX	XX

See footnotes at end of table.

Table 38.—Froth flotation of bituminous coal in 1985—Continued

Function and type	Quantity (thousand pounds)	Value (thousands)	Quantity (pounds)	Value
Total				
Filtering aids:				
Polyacrylamides	36	\$29	0.031	\$0.024
Folycamides	844	584	.261	.181
Unspecified polymer	167	559	.270	.197
Total	1,047	1,172	XX	XX

XX Not applicable.

¹These values are for the flotation section only and would exclude material processed by other separation methods. Other operating data are for the entire plant (grinding mill and concentrator).

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Fredric L. Quivic, Interviewer

Fredric L. Quivic works as a consulting historian of technology living in St. Paul, Minnesota. Much of his work is as an expert witness in Superfund litigation. While living in the Bay Area for three years, he also conducted oral histories for the Regional Oral History Office and was a lecturer in the Interdisciplinary Studies Program of the College of Engineering at U.C. Berkeley. A graduate of the St. Olaf College (B.A., Art) and the School of Architecture at the University of Minnesota, (B. Environmental Design), he has also earned an M.S. in Historic Preservation at Columbia University and a Ph.D. in History and Sociology of Science at the University of Pennsylvania. He is currently writing a history of the former Ford Motor Company assembly plant in Richmond, California, in support of the National Park Service's Rosie the Riveter World War II Homefront National Historical Park.

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